MAY 1955

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

FIVE DOLLARS A YEAR

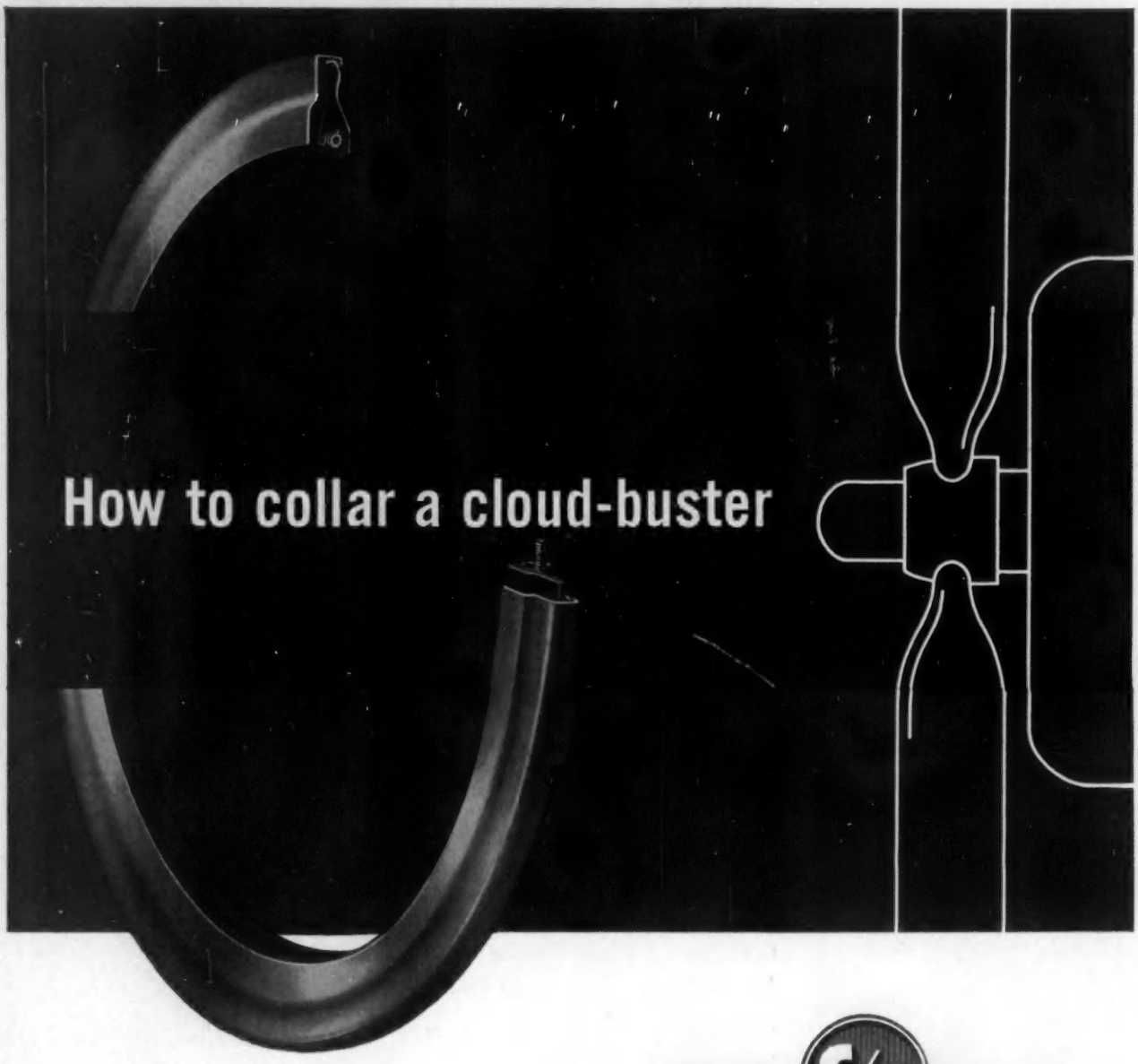
Radioisotopes in Engineering Design

Deaeration of Fluids

Sheet Metal Fabrication

Arc Resistance of Plastics

For finishes combining protection and appearance—see page 161



AND BRING COSTS DOWN TO EARTH!

Where the propeller shaft enters the gear case, the design specs called for a piston ring seal. It was dependable . . . but through cooperative efforts of Curtiss Wright and C/R engineers, a simpler seal was designed, equally as dependable but saving space and cost. It works perfectly. This C/R seal provides lubricant retention sufficient to seal a vital bearing under severe conditions. This is a typical example of C/R seal engineering service. May we help you, too, with your sealing problems? Send for your copy of "C/R Perfect Oil Seals."

C/R

PERFECT

Oil Seals

More automobiles, farm equipment and industrial machines rely on C/R Oil Seals than on any similar sealing device.

CHICAGO RAWHIDE MANUFACTURING COMPANY

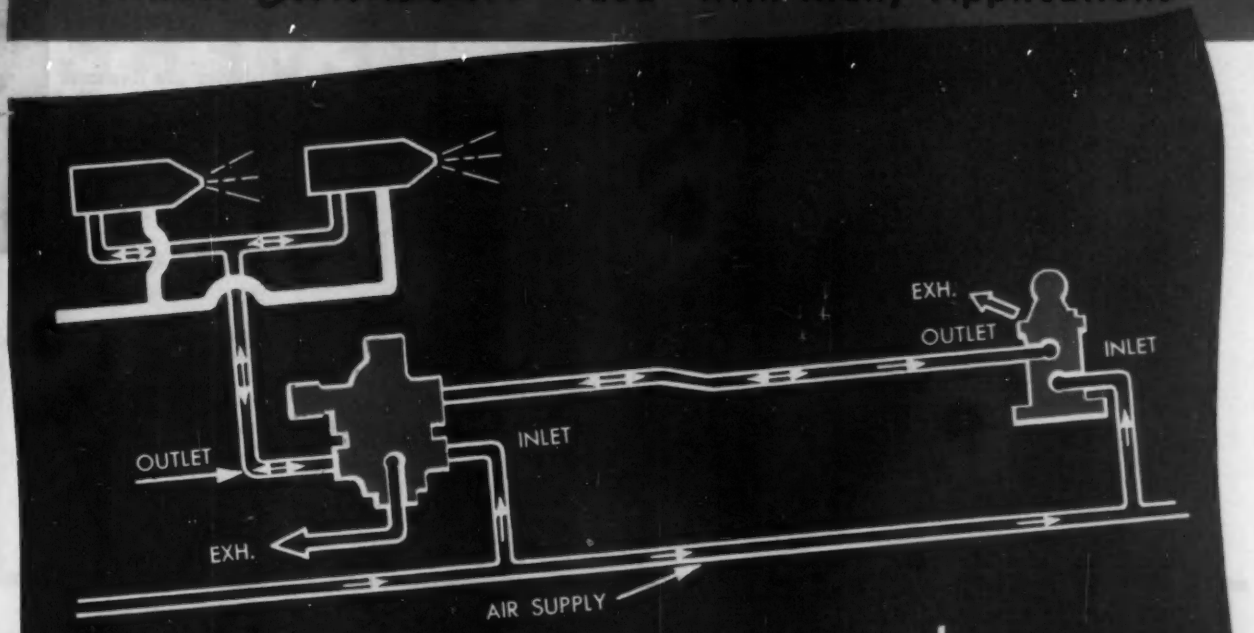
1301 Elston Avenue OIL SEAL DIVISION Chicago 22, Illinois

IN CANADA: SUPER OIL SEAL MFG. CO., LTD., HAMILTON, ONTARIO

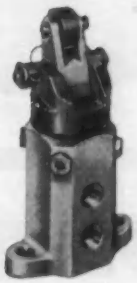
Other **C/R** *products*

SIRVENE: (Synthetic rubber) diaphragms, boots, gaskets and similar parts for critical operating conditions • CONPOR: Controlled porosity mechanical leather packings and other sealing products • SIRVIS: Mechanical leather boots, gaskets, packings and related products.

A Ross *Airmation* Idea—with Many Applications



Sprays drawing compound with every press operation



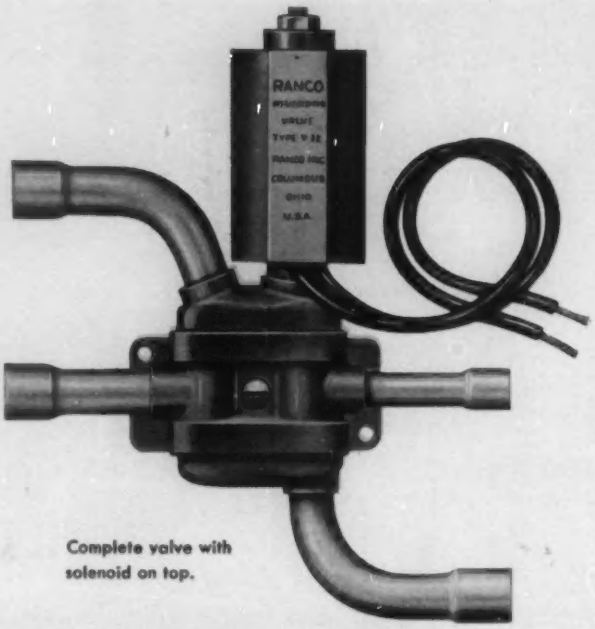
- **Designed for spraying drawing compound on panels before stamping, but adaptable to any application requiring intermittent spraying or air blasting.**
- **Reduces manual work; assures precise quantity of fluid and accurate delivery.**
- **Spray is controlled by a Ross 3 Way Normally Closed WV Sequence Valve which is remotely controlled by a Ross Cam Valve.**
- **Amount of spray time can be varied by adjusting metering stem on valve.**
- **For assistance in engineering this Airmation idea to your application, contact your nearest Ross Service Engineer. He offers practical creative assistance.**

Ross—The Bridle for Fast, Clean, Economical, Strong, Responsive Air Power

ROSS Control VALVES

Ross OPERATING VALVE COMPANY

114 E. GOLDEN GATE AVENUE • DETROIT 3 • MICHIGAN



Complete valve with solenoid on top.

REVERE

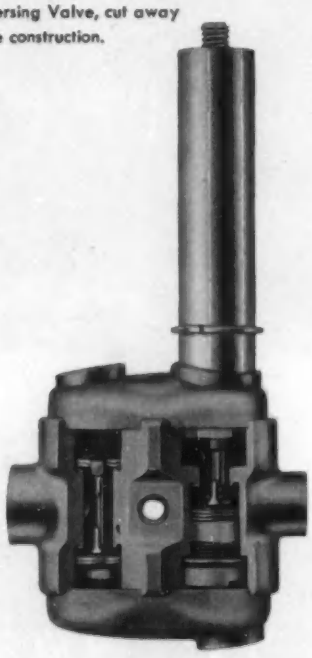
collaboration helped make this reversing valve possible

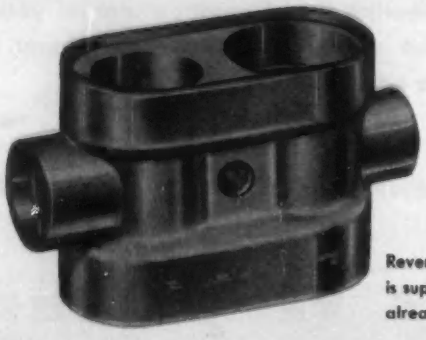
The valve shown here is unique. It is made by Ranco, Incorporated, Columbus, Ohio, and is being supplied to manufacturers of air conditioners that either cool or heat, according to the temperature. When the thermostat calls for cooling, a solenoid moves the valve to the cool position; when heat is required, the operation is reversed, automatically.

Naturally, the development of this valve took a long time. For some five years the Revere Technical Advisory Service has been collaborating closely with Ranco engineers on design and materials for control valves of various types. When the new idea was under development, Revere was called in because non-magnetic brass and copper would be required for the body. Designs were mutually studied, and it was decided to make the main portion of the body from a brass forging, which would lessen machining and provide a dense, non-porous, non-leaking part. Many thousands of these reversing valves have been shipped to makers of ½, ¾ and 1-horsepower units, without a single forging rejection. One important feature of the forging is that it makes possible silver brazing the inlet and outlet tubes so quickly that no damage is done to the synthetic valve washers. Ranco feels that the valve has a tremendous future, offering as it does completely automatic selection of heating or cooling.

When you have a new project on your boards, involving aluminum, brass or copper, we suggest you get in touch with the Revere Technical Advisory Service. Its knowledge added to yours may make your products better. See the nearest Revere Sales Office.

Ranco Reversing Valve, cut away to show the construction.





Revere Brass Forging is supplied to Ranco already machined.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities; Distributors Everywhere.

Product Engineering

MAY 1955 Vol. 26 No. 5

The McGraw-Hill Magazine of Design Engineering

Radioisotopes as Design Tools ..... Arthur M. Smith 129
Properties of eight radioactive materials of special value in engineering design; three examples of effective use; probable direction of future development.

Aeration in Lubrication and Hydraulic Systems ..... B. R. Walsh 136
Importance of avoiding entrapment; causes and methods of minimizing aeration.

Product Designs 140
Extra-maneuverable manipulator—High-speed low-upkeep mower—Low-cost water heater—Sharper definition for reducing camera—Adaptable steam engine.

Kinematic Concepts That Simplify Design ..... M. F. Spotts 152
Basic ideas that can be applied to improve and simplify the design of any mechanism.

Plate Cam Design ..... Martin Kloomok and R. V. Muffley 155
How to determine pressure angle quickly and easily, through use of a comprehensive set of 30 charts presented in full in six-page gatefold insert.

Paint Finishes ..... Norman P. Gentieu 161
Types of paint for protective finishes and for special applications; four case histories combining protective and decorative functions.

Sheet Metal Fabrication ..... Victor J. Furio 166
Twenty-three design tips to assure minimum cost in specifying sheet metal parts.

Ten Types of Belt Drives ..... George R. Lederer 172

Arc Resistance of Plastics ..... C. F. Spiers and W. C. Wikstrand 174
Data on 13 plastics insulating materials obtained by special test methods more useful than standard tests for evaluating materials for specific applications.

Adhesive Bonding ..... Jerome L. Been 181
How to select the correct fomulation and method of application; influence of chemical reactions in increasing the cohesive strength.

Pilot Control Devices ..... G. W. Heumann 187
Initiating, selecting and interlocking functions performed by manual or automatic switches; basic types for automatic control; data on current ratings of standard devices.

Solving Pythagorean Equations ..... Ernest L. Schlage 201
Table of divisors for a simple two-step method.

Section Modulus for Pipes, Tubes and Shafts ..... James J. Kerley, Jr. 205
Nomograph for diameters from 0.7 to 17 in.

DEVELOPMENTS TO WATCH 5
DESIGN PERSPECTIVES 123
EDITORIAL 127
TECHNICAL NEWS 192
COMING EVENTS 199
NEW COMPONENTS AND MATERIALS.... 206
NEW CATALOGS AND BULLETINS..... 288
SANS, SOUCI 302
ENGINEERING ABSTRACTS. 304
NEW BOOKS 312
READERS' LETTERS 318

Number of copies printed this issue 34,228

What makes it tick?

. . . High Density Mallory 1000 Metal

As the wrist moves, a tiny balance weight of Mallory 1000 Metal swings back and forth inside this dainty self-winding watch and keeps the spring wound just right.

Only by making this weight of Mallory 1000 could the watch be made so small. The high density of this unique material compresses maximum inertia into minimum space. Its excellent machinability and high degree of uniformity make it possible to produce the close tolerance demanded by this application . . . as well as for numerous uses in counterweights, rotors and other precision-made parts.

An alloy of tungsten, nickel and copper developed by Mallory's extensive research in powder metallurgy, Mallory 1000 has exceptional physical properties. Its density is about twice that of steel or brass. Its tensile strength, rigidity and hardness are comparable with many steel alloys. It can be machined readily to micro-inch finish, and has excellent weathering qualities.

Also highly efficient as a radioactive shielding material, Mallory 1000 offers space-saving opportunities in varied product designs. For information, write to Mallory today for a copy of our latest Technical Bulletin.

Highly Uniform Physical Properties

Made to strict standards of uniformity, Mallory 1000 gives you specified properties on which to base your designs . . . instead of vague "typical" characteristics.

	Average	Minimum
Density (parts up to 2500 grams)	16.96 gm/cc	16.71 gm/cc
Tensile Strength (ultimate)	112,000 psi	94,000 psi
Modulus of Rupture (simple beam, center loaded)	220,000 psi	180,000 psi
Elongation (% in 2")		2%

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry Street, Toronto 15, Ontario.

Expect more . . . Get more from

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

THIS MONTH'S COVER

For a finish combining protection and appearance, tractors made by Caterpillar Tractor Co. are first steam cleaned, washed and airblasted dry; a phosphate solution is brushed on for a paint base, and then the tractor is spray painted with two coats. This is one of the four case histories included in the article "Paint Finishes," starting on page 161.

THE STAFF

Editor **G. F. NORDENHOLT**

Assistant to the Editor **JOSEPH KERR**

Managing Editor **ROBERT W. CARSON**

Associate Editors
JOHN ALICO • RANDOLPH P. DOMINIC • E. T. EBERSOL, JR. • RICHARD M. KOFF • JAMES R. McDERMOTT

Assistant Editors **ROBERT E. ABBOTT PAUL N. ANDERSON • NICHOLAS CHIRONIS JOHN KOLB • RICHARD A. LAWRENCE NORMA J. VAN NESS**

Editorial Assistant **LILLIAN M. WITHAM**

Consulting Editor **ROBERT E. BRUCKNER**

Washington **GEORGE B. BRYANT, JR.**

Publisher **ALBERT HAUPTLI**

Advertising Sales Manager **STANLEY J. ALLING**

Reader Service Manager **C. C. KANE**

Foreign News Bureau: **LONDON • PARIS • BONN • SAN PAULO • MEXICO CITY • TOKYO**

Product Engineering
A McGRAW-HILL PUBLICATION

May, 1955 **Vol. 26, No. 5**

Published monthly by the McGraw-Hill Publishing Co., Inc., Executive, Editorial, Advertising and Subscription offices **McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Publicatio office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice President Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President, Editorial Director; Joseph H. Allen, Vice President, Director of Advertising; J. E. Blackburn, Jr., Vice President and Circulation Director.

FOR SUBSCRIPTIONS, write to: Subscription Service, 330 West 42nd Street, New York 36, N. Y. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. **Orders must indicate company and position.** Allow one month for change. Single copies 50¢. United States and possessions, in address.

$5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $10 for two years, $12 for three years other Western Hemisphere and the Philippines, $15 for one year, $25 two ons years, $30 for three years all other countries, $25 for one year, $40 for two years $50 for three years. Entered as second class matter Aug. 21, 1936, Albany, N. Y. Post office, under act of Mar. 3, 1936, Albany, N. Y.

U. S. A. Copyright 1955 by McGraw-Hill Publishing Co., Inc.—All rights reserved.

Developments

To Watch

ALL FERROUS METALS RESIST CORROSION . . . .

. . . . with a new process that diffuses chromium into the metal and forms a stainless surface alloy to depths from 0.001 in. to better than 0.008 inch. Without causing any dimensional changes, this process will protect ferrous metals under severe atmospheric, water, and chemical corrosion conditions; resist thermal oxidation up to 1700F; and resist heavy wear and abrasion. The surface will not chip, crack, or peel when the coated piece is bent 180 deg., stretched or twisted. Products can be welded before or after processing, using the mild steel procedures before processing, and the stainless steel procedures after processing. In addition, parts using this process can be brazed and spot welded. In spot welding, after treatment, the mild steel procedures are still used. According to the manufacturer, Alloy Surfaces Co., 1115 N. 38th St., Philadelphia 4, Pa., the process will make parts available with resistance characteristics at costs less than stainless steel, and can be used on small products like nuts, bolts, washers and clamps. Grey iron and malleable iron castings, and meehanite can be treated.

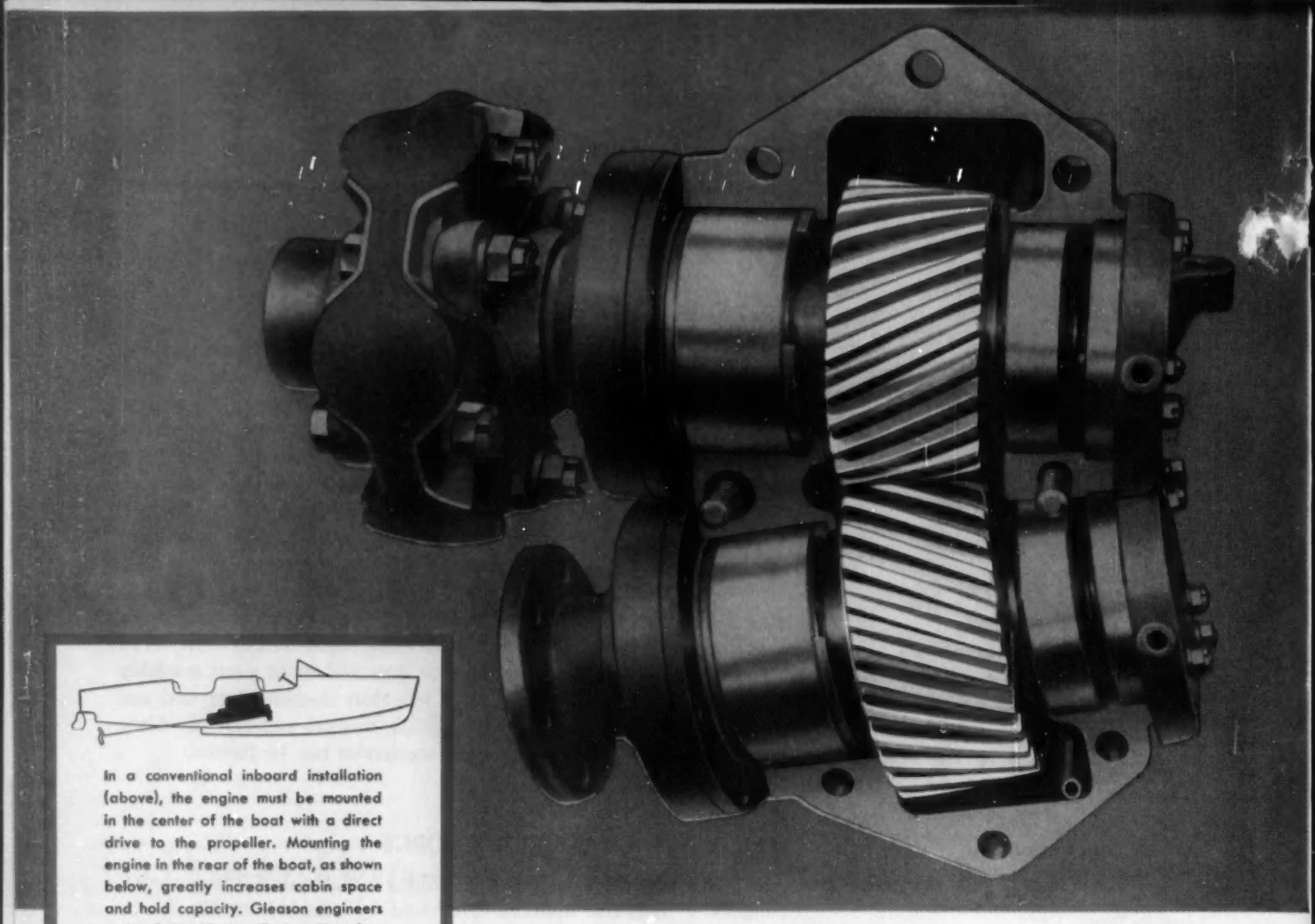
WITH A HIGHER COERCIVE FORCE . . . .

. . . . than any available permanent magnetic material (3,800 oersteds), Bismanol, a magnetic material discovered by scientists at the U. S. Ordinance lab., Silver Spring, Maryland, is finding application where great forces toward demagnetization are exerted. Because of this coercive force, the new material exceeds any other permanent magnet, except the platinum-cobalt alloy, in available flux density in short magnets where length-to-diameter ratio is less than one. Bismanol is being used by the Air Force in traveling-wave tubes, an important component in a new type radar which not only locates the enemy, but also sweeps a wide range of frequencies to determine whether the enemy has located us. The tubes provide amplification of signals at higher frequencies and band-widths than are otherwise possible. In this particular application, Bismanol has cut the weight of the finished assembly by 100 lb., because it eliminates several other components.

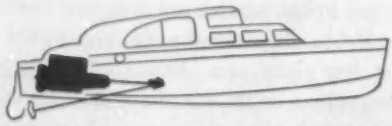
SUPER PURE ALUMINUM . . .

. . . . containing better than 99.99 per cent of aluminum has been reported by the British Aluminum Co., Ltd., Norfolk House, St. James Square, London, S.W. 1, England to be available in sufficient quantities to permit commercial use. Principle impurities are silicon, iron, and copper. The metal is made by a three layer electrolysis in which about 3 per cent copper is added to aluminum of commercial purity to produce the heavy bottom layer. This is covered by a layer of molten flourides and chlorides—usually sodium, barium, and aluminum, with the barium being added to give the proper density. The super pure aluminum collects above this molten flux. Uses are flashing and roofing material, extruded cable sheathing and electrolytic condensers.

(continued on page 7)



In a conventional inboard installation (above), the engine must be mounted in the center of the boat with a direct drive to the propeller. Mounting the engine in the rear of the boat, as shown below, greatly increases cabin space and hold capacity. Gleason engineers assisted the Marine Engine Manufacturers in the development of the V-Drive.



Angular power transmission can improve *your* product, too

Take, for example, this marine V-Drive. The use of spiral bevel gears permitted a design which released more usable space in the boat, improved balance, and simplified installation.

This is just one instance of the added flexibility of product design possible with angular power transmission.

Faster production and lower costs will also result from using this type of transmission.

If you have a design application for bevel or hypoid gears, the Gear Engineering Department of the Gleason Works is ready to help you realize every advantage possible. Design and production recommendations for your angular drive are offered at no obligation.

If you would like to discuss your bevel gear application with a Gleason representative, please contact us.

These Gleason Technical Handbooks are available on request:

Spiral Bevel Gear System
20 Straight Bevel Gear System
Zerol® Bevel Gear System

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

Developments to Watch

TITANIUM POWDERED METALLURGY TECHNIQUES . . . .

. . . . developed by The Brush Laboratories, Cleveland, O., are resulting in a reduction in scrap and machining time in the production of complex titanium parts. Reports are that the parts may be made by the hot press forming method, which is used mainly for large parts, or by the press forming method for small and medium sized parts. With the hot press forming, a high vacuum is used to prevent contamination, and a high temperature is used to remove the volatile constituents, as well as to insure maximum density with moderate pressure. Graphite dies are used, and costs claimed to be as much as 20 per cent less.

HIGH TEMPERATURE, HIGH PRESSURE . . . .

. . . . plastic hydraulic hose, based on Du Pont's fluorocarbon plastic (Teflon), has been developed by Resistoflex Corp., Plansoen St., Belleville 9, N. J. for use in military and commercial jet aircraft. The hose is not affected by heat or chemical attack at temperatures over 400F. Three sizes of the hose have been produced and are now undergoing tests.

THE SMALLEST RECHARGEABLE STORAGE BATTERY . . . .

. . . . is about the size of a postage stamp and is finding use in portable communications, telemetering, and photographic equipment, says its manufacturer, Yardney Electric Corp., 46 Leonard St., N. Y. 13, N. Y. Estimates are that this 1/10 ampere/hour battery could operate an electric wristwatch for more than a year before needing recharging. Called the Silvercel, the battery measures 3/16 by 5/8 by 1 1/8 in. high, and weighs 1/6 of an ounce.

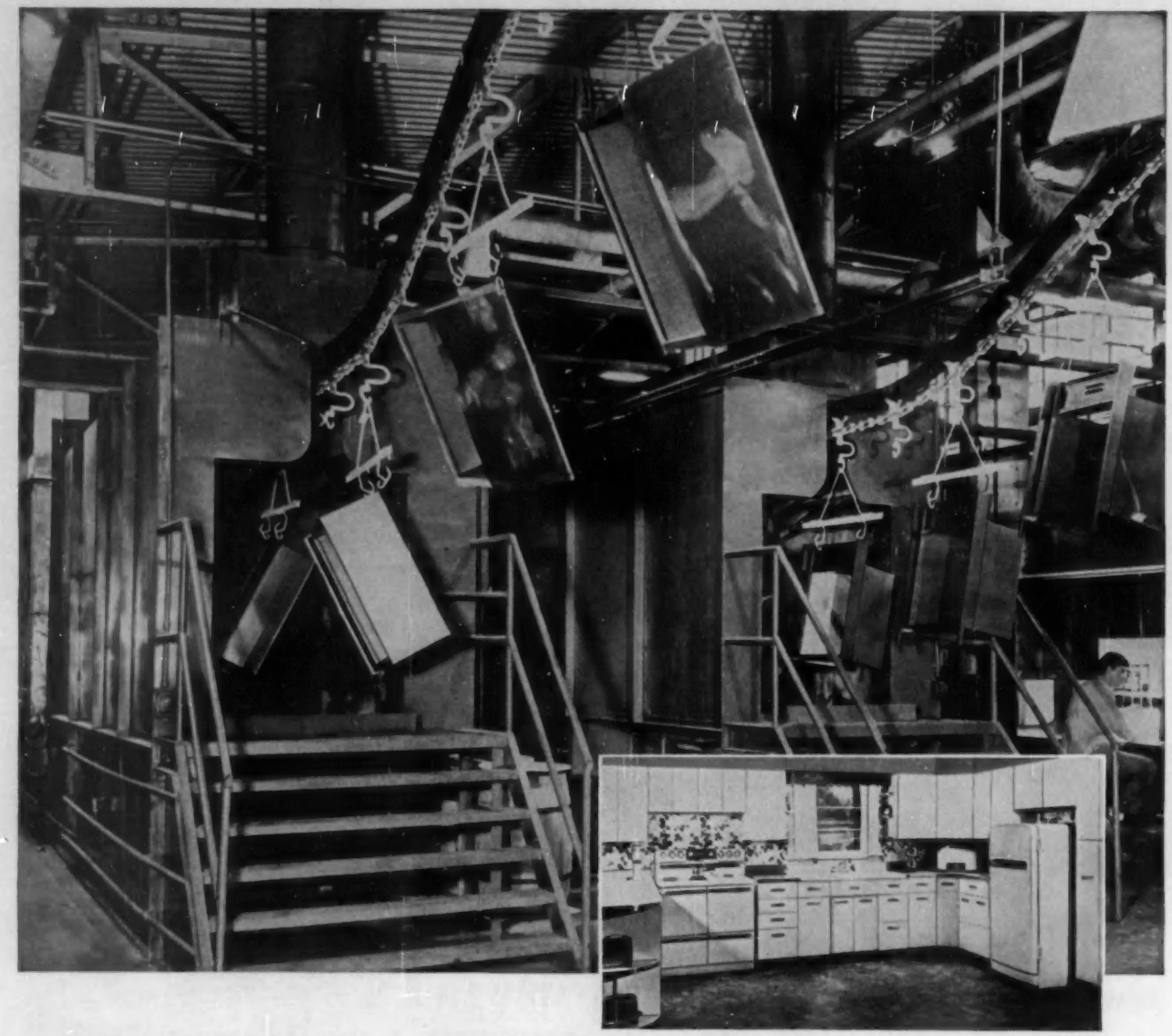
NEW ZINC BASE ALLOY STANDARDS . . .

. . . . are now being made available to industry for both laboratory and production quality control standards. These standards will give industries using these alloys an accurate, basic yardstick with which they can compare the composition of any heat or melts they are running in production. Those who developed the overall standards plan were General Motors Research Laboratories, the Chicago branch of The National Lead Co., and The National Bureau of Standards. The standards are about one inch long and 1 3/4 in. square cut from a bar continuously cast with National Leads continuous casting process.

AVAILABLE IN POROUS AND NON-POROUS FORMS . . . .

. . . . a new sheet material called Fiberfilm will permit manufacturers of electrical components to design more efficient electrical insulation into their products, according to the manufacturer, American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y. The new sheets are made from glass microfibers and polytetrafluroethylene, and depending upon the operating conditions, they will perform satisfactorily in the range of 400 to 480F. Electrically, the dielectric breakdown strength is satisfactory in the range from 1,400 to 4,000 V/mil d-c, depending on the type of film. The non-porous sheet can be made in thickness from 0.8 to 1.7 mils, and as laminations of different thicknesses. The porous sheet is available from 0.6 to 13 mils. Some uses are high temp. coils and transformers.

(*continued on page 9*)



How to get a "Bulldog Grip" on beauty!

The bright, shiny new paint finish looks wonderful when it comes off the production line. Looks equally fine in the showroom, when the customer makes her choice.

Then it gets out into service, and the real test begins.

Bonderite's "bulldog grip" holds paint finish to metal. In Bonderite installations like the one shown above, the surface of the metal (before painting) is converted chemically to a nonmetallic coating integral with the metal which resists corrosion, confines damage from scratches to the site of the injury itself. It's satisfaction insurance, used today on leading painted products of all types where lasting fine appearance is important.

If you aren't now using Bonderite on your painted metal products, better check up and learn how economically you can have its advantages. Call or write today!

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U. S. Pat. Off.*

Since 1915—Leader in the Field

PROTECTED BY Bonderite PARKER RUST PROOF COMPANY QUALITY CORROSION RESISTANT

PARKER RUST PROOF COMPANY

2179 E. Milwaukee, Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

Developments to Watch

A NEW DEEP-DRAWING RIGID VINYL SHEET . . . .

. . . . made by Bakelite Co., Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., N. Y., is said to cut costs of all deep-drawn vacuum formed objects. Compounded for easier and faster forming at high temperatures, the new sheet is calendered so free of internal strains that any decorations applied to the flat sheet are not distorted during the forming process. Bakelite claims it is the first low cost calendered rigid sheet produced in thicknesses up to 0.040 in., and in width up to 51½ inches. The sheet can be calendered with a surface comparable to that of a matted sheet.

FAST SETTING SEALER FOR CASTING IMPREGNATION . . . .

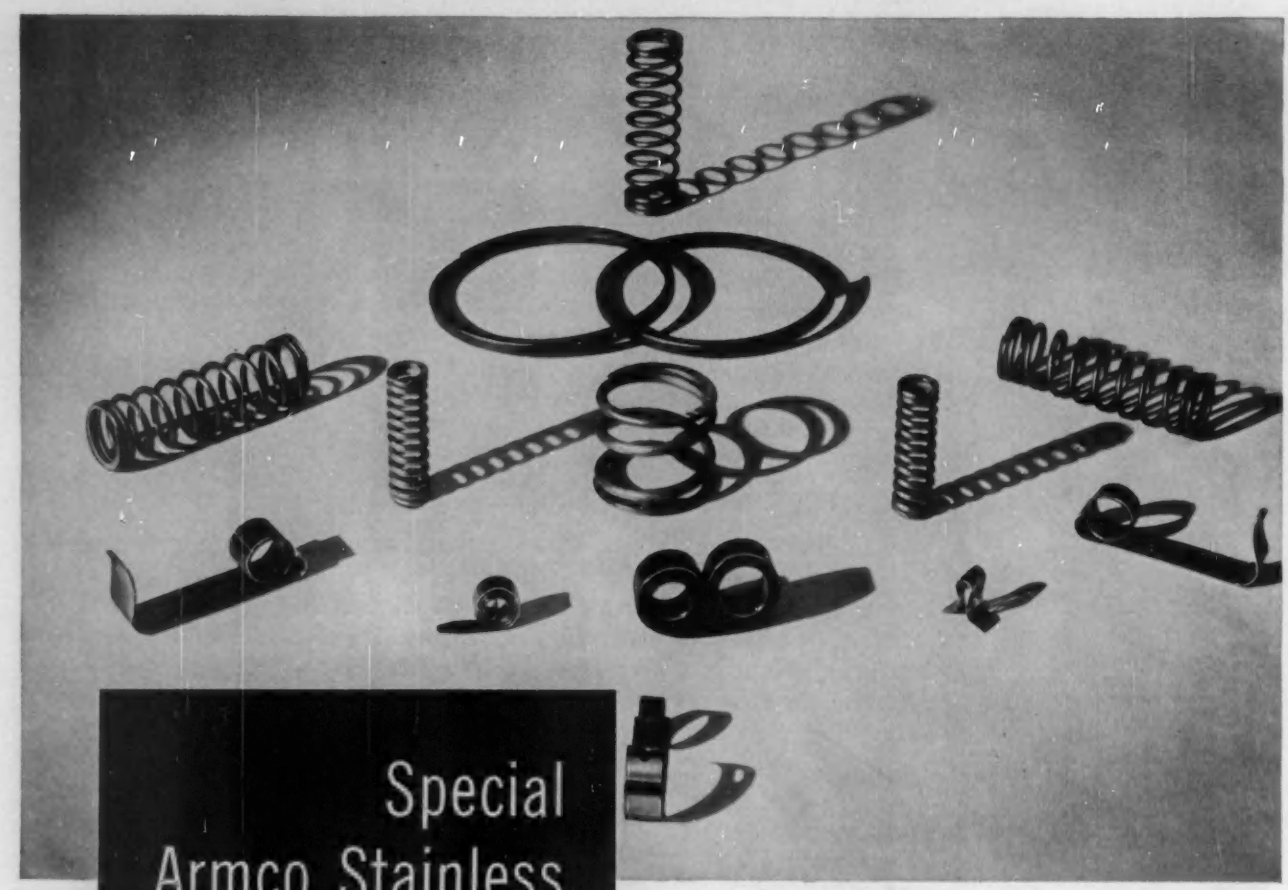
. . . . can be used on all types of metal castings and with all known types of welding alloys to impregnate welded joints of fabricated parts. The seal is a vehicle carrying minerals and metal oxides which will eliminate porosity in brass bronze, gray iron, malleable iron, steel, zinc, aluminum and magnesium sand and die castings. Available from Prenco Products, Inc., 507 East 10 Mile Rd., Hazel Park, Michigan, the new sealer is recommended for use in advance of machining operations. Parts with baked-on enamel surfaces, and chrome and nickel plated parts also can be sealed.

NICKEL-BASE ALLOYS FOR BRAZING AND COATING . . . .

. . . . developed by the Coast Metals, Inc., Little Ferry, N. J., will make it possible to join heavier sections which formerly were considered unsuitable or impractical for brazing. The new joining materials are said to have mechanical, corrosion resistance, and oxidation resistance properties comparable to stainless steels and heat-resistant alloys. The new brazing alloys contain from 71 to 93 per cent nickel, with silicon and boron common to all. In the low nickel alloys, 7 to 16 per cent Chromium and 3 to 4 per cent Iron may be present. The new alloys are suitable for joining metals with melting points above 1850F. Examples include Nichrome, Inconel, and stainless steels of the austenitic type.

AND IN ADDITION . . . .

. . . . Reflin Industries, P. O. Box 452, Gardena, Calif. is now making tough 12 in. dia. rigid reinforced plastic pipe out of polyester resin and fiber glass. . . . . Ford Motor Co. has announced a successful automotive gas turbine heat exchanger which attained an efficiency of 83 per cent at idling engine operation; the recovered heat preheats the incoming combustion air. . . . . Titanium Metals Corp. of America, 233 Broadway, N. Y. 7, N. Y., has cut its titanium sponge price from $4.50 to $3.95 a pound; bars and billets down to $11.10 from $12 a pound; and sheet and strip from $18.50 to $17.25 a pound. . . . . An automatic landing system developed by Bell Aircraft of Buffalo, N. Y. has made several hundred landings without pilot aid in weather conditions that would normally prevent Naval carrier operations; wounded or fatigued pilots can be brought down the same way. . . . . The AEC has joined with the Baldwin-Lima-Hamilton Corp., Pennsylvania R. R., and the Denver & Rio Grande R. R. in a study of a nuclear powered reciprocating engine for locomotive use. . . . . The Society of Die Casting Engineers has just been formed to cover the fields of die casting, finishing, plastics molding, and powdered metals; address is 175 Railroad St., P. O. Box 46, Northville, Michigan. . . . . Refuting favoritism charges, Harlow Curtice, Pres of G.M., claims that since the present Administration took office in Jan. 1953, GM has received only $15-million of new defense orders while defense order cancellations amounted to $549-million.



Special Armco Stainless Spring Wire HAS STRENGTH OF MUSIC WIRE

A special Armco Stainless Steel, known as 17-7 PH, has proved far superior to 18-8 as a spring material. It is also better than non-ferrous spring wire in applications where higher strength is needed. Here are some of the characteristics of this grade of stainless steel.

High Load Capacity

Mechanical properties and modulus of elasticity of Armco 17-7 PH Stainless Steel wire are generally comparable to music wire. This means that the same spring capacity can be obtained in a corrosion and heat resistant spring as in a carbon steel spring, without increase in size.

High Elastic Limit

Armco 17-7 PH springs have a wide deflection range in which they are safe from permanent distortion. This is because of the high torsional elastic limit of the wire — 55 per cent of the ultimate tensile strength.

Better at Elevated Temperatures

Relaxation of helical compression springs of Armco 17-7 PH at temperatures up to 650 degrees F is considerably less than for 18-8 or music wire.

Torsional modulus of 11,000,000 psi is less affected at temperatures up to 650 degrees F than 18-8 or music wire.

Dimensional Stability

After fabrication, only a single heat treatment at 900 degrees F is required to develop full mechanical properties and this treatment stress-relieves as well. Spring dimensions are not affected by this hardening treatment because of the high dimensional stability of Armco 17-7 PH.

Armco 17-7 PH is supplied for coil or flat springs, in bars, sheets, strip and plates. A companion precipitation-hardening grade, Armco 17-4 PH, is supplied in bars.

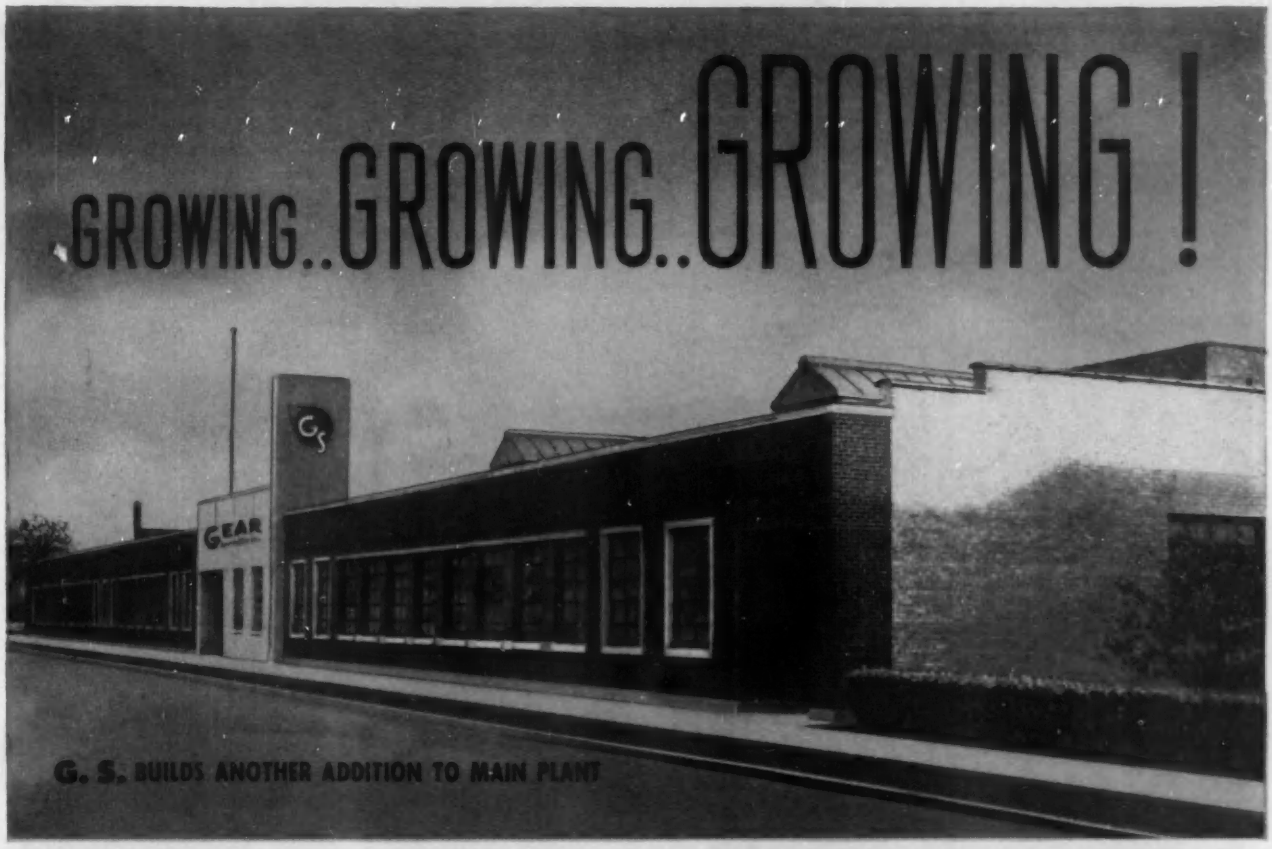
For further information, write us at the address below.

ARMCO STEEL CORPORATION

865 Curtis Street, Middletown, Ohio

Sheffield Steel Division • Armco Drainage & Metal Products, Inc. • The Armco International Corporation

GROWING..GROWING..GROWING!



G. S. BUILDS ANOTHER ADDITION TO MAIN PLANT

FRACTIONAL HORSEPOWER GEARING

GEAR
Specialties, Inc.
2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS

SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS
OF FRACTIONAL HORSEPOWER GEARING

More Space To Better Serve Our Customers

A big, modern addition to our main plant has just been completed. This major expansion was made necessary by the rapidly increasing demand for G. S. Small Gearing by more and more of our country's most critical buyers. New customers as well as those we've served for many years can expect better service, even better Gears, and greater efficiency.

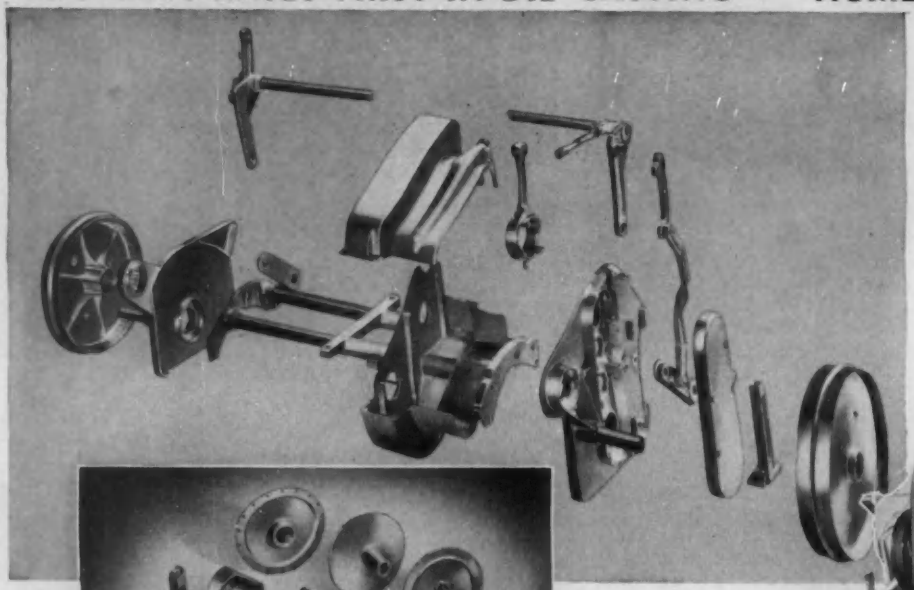
Now, more than ever, G. S. enjoys the enviable position of *"world's largest exclusive manufacturer of fractional horsepower Gearing"*. Thirty nine years of specialization . . of developing and perfecting mass production methods and machines . . has resulted in maintaining a degree of accuracy unapproached in the history of fine Gear making!

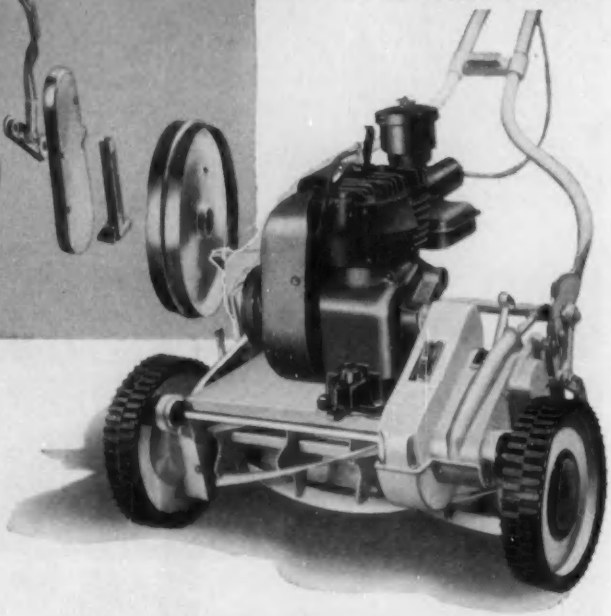
Profit by depending upon our expert staff and enlarged facilities for quick, correct answers to ALL your Small Gearing problems. Will you tell us today, please, exactly what you need?

GET G.S. TECHNICAL DATA *Free!*

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. Folder contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

WHY ZINC RATES FIRST IN DIE CASTING • NUMBER 2 OF A SERIES





◀ The castings pictured at the left can be identified readily on the finished mower, while those in the group below are hidden in the assembly. A total of 32 ZINC die castings are used in the machine itself and two more on the handle.

toughness— as proved by CLEMSON

In designing the new reel-type "Power Drive" mower, Clemson Bros., Inc. has employed ZINC die cast components wherever possible—with full assurance of their durability. Behind this decision lies over 15 years of outstanding performance of ZINC die castings in Clemson's well-known hand mower. And the use of this metal and method of production not only insures efficient, dependable service, but provides smooth surfaces for a finished appearance that could not be matched at comparable cost by any other means of manufacture.

The impact strength of ZINC die castings exceeds that of the other commonly used die casting alloys. And this ability to withstand sudden shock is only one of the strength characteristics which account for the preference for ZINC. Outstanding in tensile and compressive strength, as well as in ductility and hardness, ZINC die castings get the call where *toughness* is an important consideration.

Send for your copy ➡

High strength is just one of the many reasons why ZINC rates first in die casting. We suggest that you watch these pages in the months ahead for other examples of ZINC die casting advantages in product design. In the meantime, send for our new brochure and contact any commercial die caster for assistance in solving your particular production problems.

The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

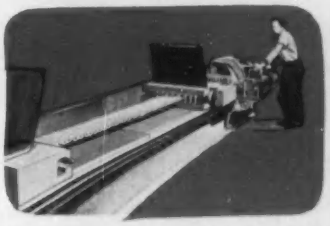
ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

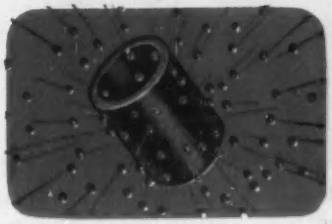
These LINK-BELT Roller Chain EXTRAS

put more life into your machines

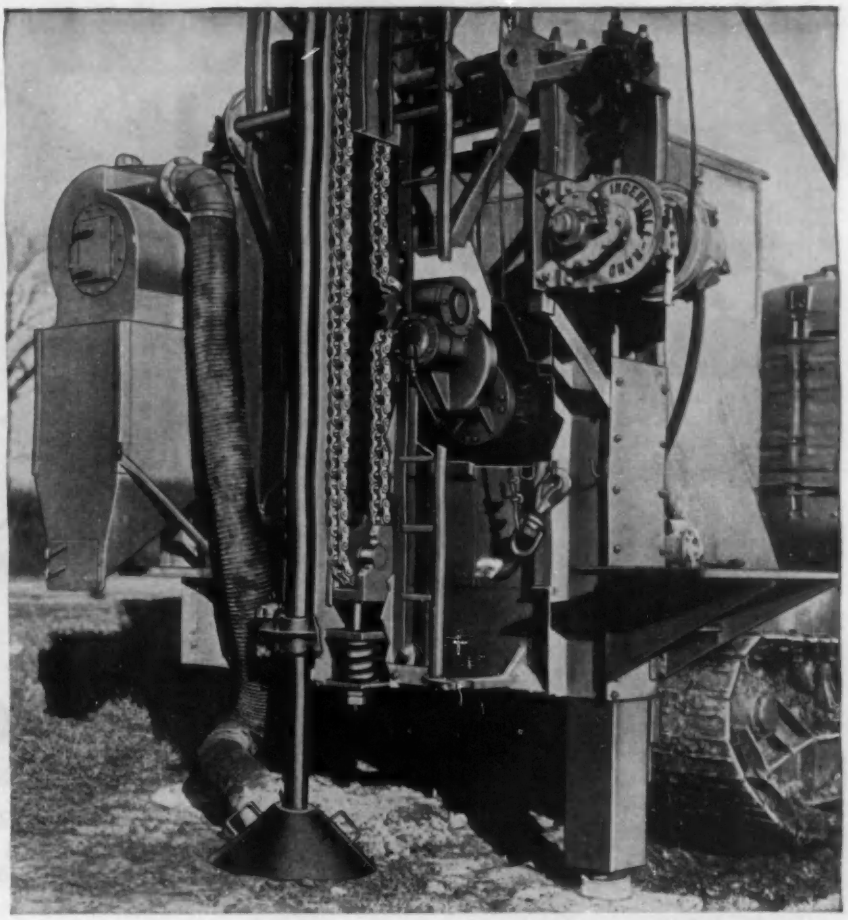
LOCK-TYPE BUSHINGS (applied on a range of sizes) end a common cause of stiff chain.



PRE-STRESSING of multiple width chain provides uniform load distribution.



SHOT-PEENED ROLLERS have greater fatigue life, added ability to withstand impact.



Ingersoll-Rand uses Link-Belt Precision Steel Roller Chain for positive drill feed on their Quarrymaster primary blast-hole drill.

THROUGHOUT every stage of manufacture, Link-Belt takes *extra* care to build *extra* life into Precision Steel Roller Chain. Shown above are three of these added refinements . . . and there are many others which contribute to better performance and longer life for your machines.

You can choose from a wide range of Link-Belt roller chains and sprockets. In addition, Link-Belt's complete line includes silent chain drives . . . and all sizes and types of cast, combination, forged and fabricated steel chain.

Data Book 2457 will aid you in selecting and ordering roller chain. Get your copy from the nearest Link-Belt office now. And remember to see Link-Belt for all your drive and conveying chain needs.

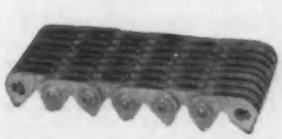
LINK-BELT

CHAINS and SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13,720

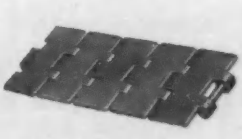
No one chain serves every purpose . . . get the RIGHT one from Link-Belt's complete line



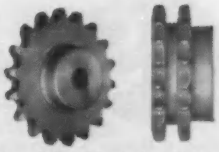
Silent Chain

LXS Steel Chain

Detachable Steel Link-Belt



S-815 Flat-Top Chain



Cast and Cut-Tooth Sprockets

Meet U.S. STEEPGRADE the new Package Belt for steep inclines

No belt was ever better named than the U.S. SteepGrade! Its *new*, exclusive surface design gives positive non-slip control in carrying many materials on descents or ascents as *steep as 45 degrees*. The multiple rows of deep gripper-cleats hold packages and other articles firmly, prevent "avalanches" at critical angles. The ability of U.S. SteepGrade to work at such steep inclines, saves valuable floor space, conveyor length and belt footage. U.S. SteepGrade is the truly modern package belt.

Made by United States Rubber Company from strong, resilient rubber, U.S. SteepGrade's unique deep gripper-cleat design *insures* proper grip and longer wear. Special molding process makes belt and cleats one unit; this exclusive feature prevents gripper-cleats from being torn off by heavy cases. Surface design incorporates self-cleaning action as belt flexes over pulleys—cleans as it flexes!

For more facts about this great new belt, get in touch with any of our 27 "U.S." District Sales Offices or write address below.

"U.S." Research perfects it..."U.S." Production builds it... U.S. Industry depends on it!

UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

NEW! For severe impact and heavy loads LINK-BELT presents

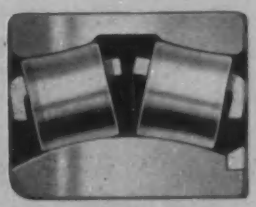
"MILL BEARINGS"

Link-Belt "Mill Bearings" are part of industry's most complete line of ball and roller bearing blocks.

STEEL PILLOW BLOCKS are the answer wherever bearings must withstand great shock and impact loads—as on steel mill, foundry, oil drilling, mining, construction and other heavy-duty equipment. That's why Link-Belt offers this line of Mill Bearings.

Perhaps your bearing demands are less extreme. Whatever your need, you'll find the right answer in this complete line of pillow blocks . . . plus flange, flange-cartridge, cartridge, take-up and hanger blocks and self-aligning roller bearings. Ask your nearest Link-Belt office for a copy of the helpful 120-page Data Book 2550 on the full line, and 8-page Book 2565-A on Link-Belt "Mill Bearings."

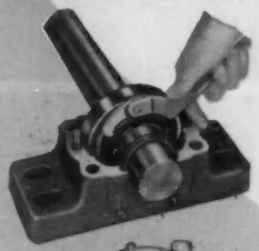
All these important differences are found only in Link-Belt "MILL BEARINGS"



FREE-ROLLING SELF-ALIGNMENT. Adjusts immediately in all directions, assuring full load capacity, even when subjected to shaft deflections and inaccuracies of mounting. Important because "Mill Bearings" are subject to heavy, sudden shock loads.

ONE BASIC HOUSING accommodates either type of seal shown at left. They keep lubricant in and dirt out.

Left, Spiral Labyrinth Steel Seals for heat conditions, oil or grease lubrication. Right, combination felt and synthetic rubber contact type seal for dusty conditions, grease lubrication.



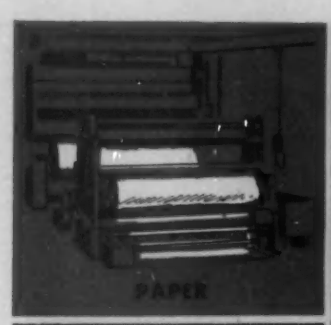
EASY INSTALLATION AND MAINTENANCE. Removal of cap means removal of bolts and hence no interference with assembly and inspection.

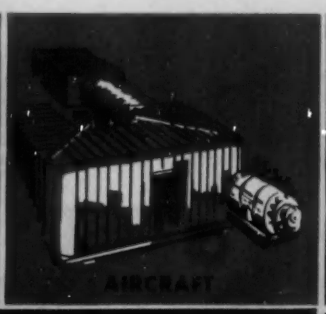
SUPER-RUGGED STEEL HOUSING. Four large heat-treated thru-bolts lock with heat-treated alloy steel serrated nuts to firmly clamp cap and base, permitting maximum radial and thrust loads. Big base area supports the bearing and withstands the extremely heavy pounding of mill and other grueling operations.

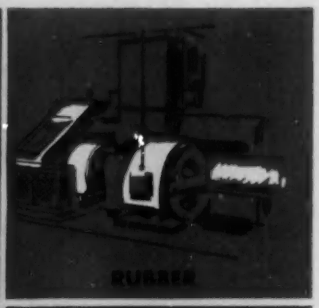
LINK-BELT

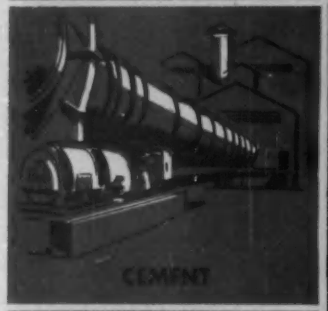
Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,710









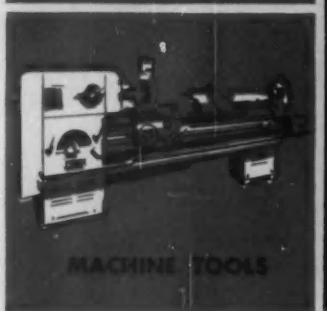
DYNAMATIC®

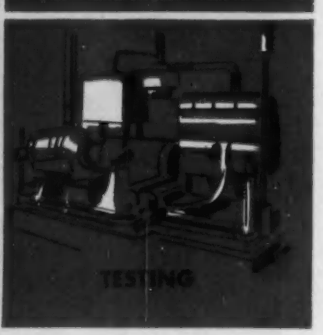
ADJUSTABLE SPEED EDDY-CURRENT DRIVES, COUPLINGS, BRAKES, DYNAMOMETERS

The Modern Method of Adjustable Speed Control and Testing for a Wide Range of Industries

Dynamatic Eddy-Current Couplings, Brakes, Dynamometers, and Ajusto-Spede® Drives are in use today in practically every industry—both in plant equipment and end products. They offer the advantage of rapid response, wide speed range, quiet operation, low power loss, low maintenance cost, and infinitely adjustable speed control from an AC power source.

Send for our new Bulletin GB2, describing and illustrating the basic Dynamatic Eddy-Current units.





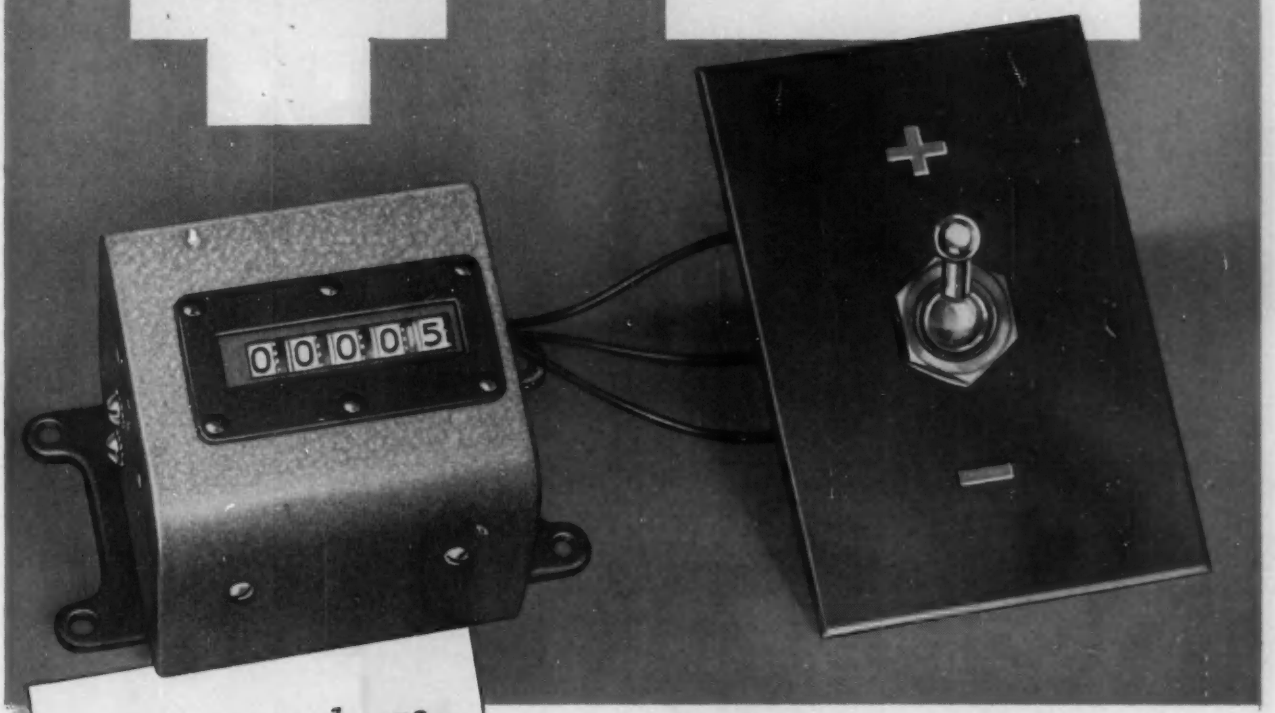
EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

EATON® **PRODUCTS:** Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steels • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

This Magnetic Counter

Adds and Subtracts



Added Evidence that —

Everyone Can Count on VEEDER-ROOT

Flip the switch up . . . the counter adds. Flip it down . . . it *subtracts*. And this 2-way countability makes this new counter a distinct asset to modern systems of automation, control engineering and stock control. Readily adaptable, easily installed and connected to existing circuits, the Veeder-Root "plus or minus" counter is a reliable double-check on the operation of machines, processes, systems. And it's just one of scores of standard and special Veeder-Root Counters for every field of reckoning from atomics to electronics to automation. What is *your* counting problem? Let's put a mathematical eye on it . . . write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

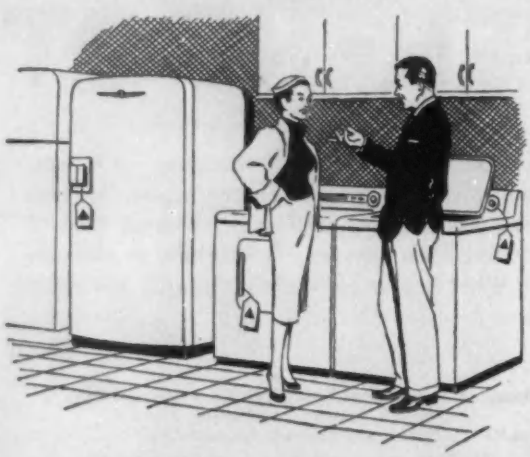
"The Name that Counts"

DELCO
DAYTON OHIO

Delco engineers

to give you

DELCO



"The lady who is wise will ask to be advised if it's powered with a Delco Electric Motor."

"Job-fitted" Delco Electric Motor performance for your product begins on *your* drawing board.

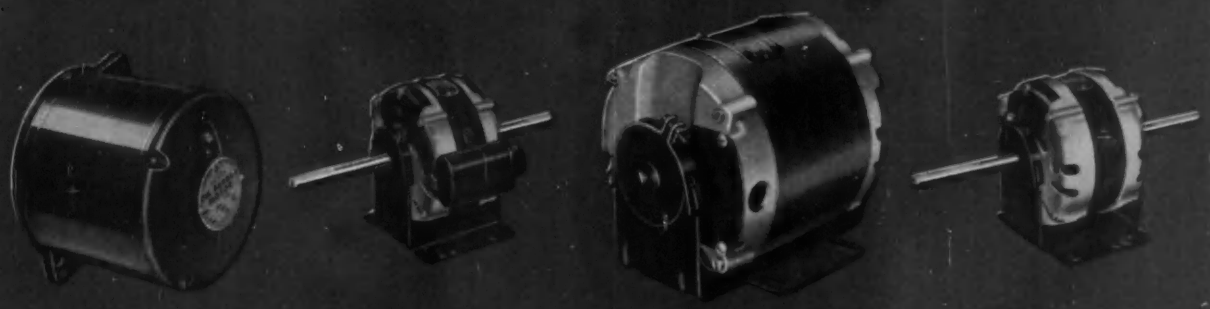
Mechanical fitness and correct electrical adaptation are proved in *your* laboratory.

Through each step from design to production, Delco engineers work with your engineers to make *sure* every Delco Electric Motor exactly

★ ***See Delco Electric Motor advertising in The Saturday Evening Post and Better Farming for the full Delco story.***

work with your engineers

"Job-Fitted" Electric Motors



fits your own application and requirements. And for on-time delivery of motors—in any quantity, wherever you want them—you can depend on Delco.

That's why Delco Electric Motors power more nationally famous appliances than any other make—why it's "Delco Preferred" in industry.

From small fractionals to giant integrals, there are Delco Electric Motors to fit your products and meet your industrial needs. Every one is built to rigid standards of quality, and subjected to rigorous tests throughout production.

Delco Electric Motor parts and service are available to your customers everywhere.

GM GENERAL MOTORS DELCO

DELCO *Electric* MOTORS

DELCO PRODUCTS, DIVISION OF GENERAL MOTORS, DAYTON, OHIO

Proved best by Performance!

Enjay now foremost butyl rubber supplier

90,000 tons yearly production of Enjay Butyl, now available from its originators, will go into varied industrial products

Enjay Company, Inc., a pioneer and leading supplier of petroleum chemicals, will market Butyl and supply advisory service in its applications.

The low price and high-level performance of Enjay Butyl allow it to replace natural and other rubbers now used in industry. Enjay Butyl is the rubber that combines high resistance to aging . . . abrasion . . . tear . . . chipping or cracking . . . ozone or corona . . . chemicals and gases . . . heat . . . cold . . . sunlight . . . and moisture.

The new Enjay Laboratories, located at Linden, New Jersey, are equipped to provide expert technical assistance in compounding and adapting Enjay Butyl to individual uses and requirements.

Distinctive properties and low price give Enjay Butyl wide industrial application

Inner tubes are made of BUTYL because BUTYL holds air ten times better than natural rubber. Its impermeability to gases promises many uses.

1955 cars use Butyl for dozens of rubber parts, because BUTYL has super-durable resistance to aging or deterioration on exposure to heat, cold, sun, weather, and chemicals.

High voltage electrical cables are made with BUTYL because BUTYL offers superior corona and ozone resistance, combined with excellent heat, cold, and abrasion resistance.

Tractor tires are made with BUTYL because BUTYL gives low tread wear and high resistance to weather, cracking, cutting, and chipping.

Protective clothing, tank linings, belt covers, hoses, and other equipment in contact with chemicals use BUTYL because of its exceptional resistance to chemicals.

GIANT TOWERS at a plant producing Enjay Butyl reflect the massive achievement of manufacturing rubber from petroleum.

FOR FULL INFORMATION
and technical assistance on applications or supply of ENJAY BUTYL, write or phone

ENJAY COMPANY, INC.
MAIN OFFICE: 15 West 51st St., New York 19, N. Y. Tel. PLaza 7-1200.
DISTRICT OFFICE: 11 South Portage Path, Akron 3, Ohio.

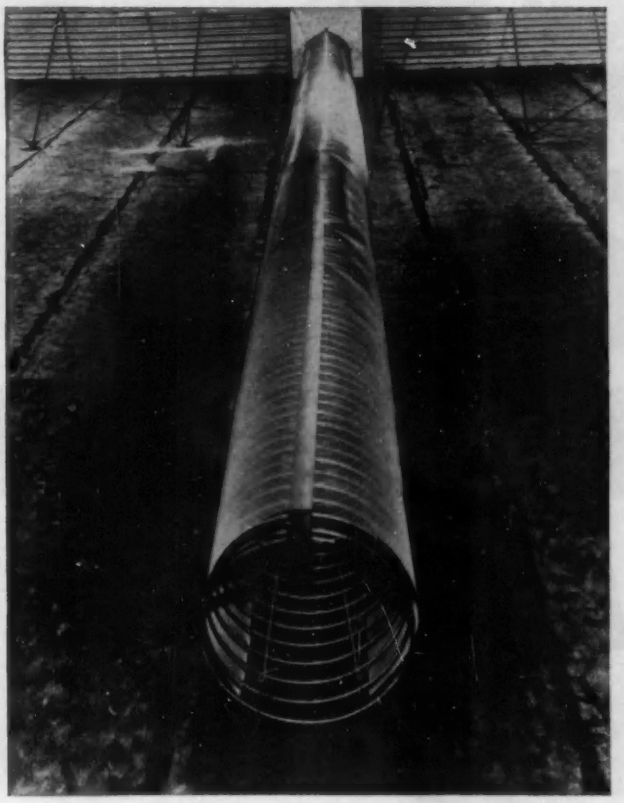
ENJAY BUTYL

Can you guess what these American

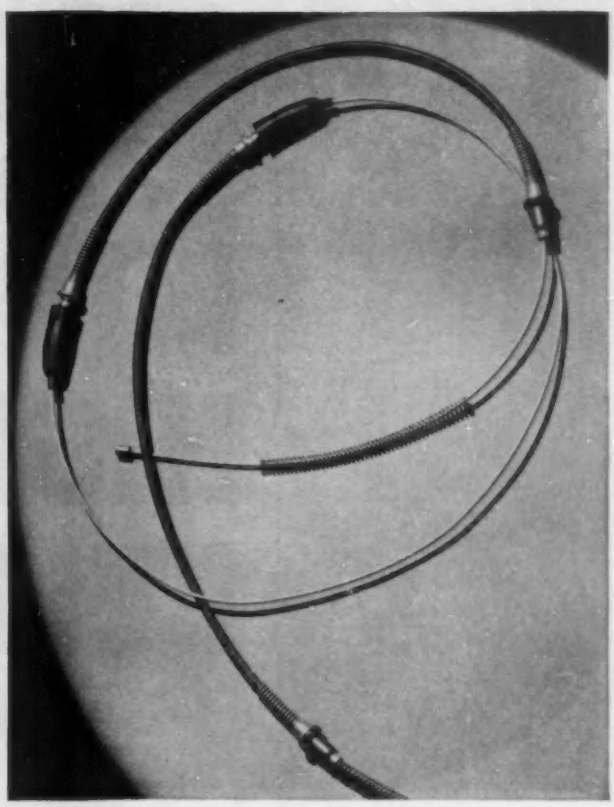
A _____

Quality Springs are used for?

B _____



C _____



ANSWERS

A **CAR-PROOF.** You're looking at the wall of a striking new parking garage just erected in Chicago. American Steel & Wire furnished miles of stainless steel strand that runs continuously from the roof to the ground—where it is stretched tight by means of American Quality Springs. Appearance is breathtaking, and the novel construction prevents cars from rolling off the concrete slabs.

B **ONE LUNG GRAIN BIN.** When grain is stored, it *must* be adequately ventilated. American Steel & Wire produced thousands of these enormous steel "springs" that can withstand tremendous radial loads. In fact, they are laid on the floor of the bin, wrapped with AS&W Insect Screen, then covered with tons of wheat. Air can then be pumped through the tube, and the wheat stays dry and in good condition.

C **YOU USE IT ALMOST EVERY DAY.** It's not a terrifying medical instrument. Rather, this collection of cable, springs, clips and rubber boots is the entire parking brake assembly for a famous automobile. This entire unit was produced by American Steel & Wire.

●Remember, American Steel & Wire can supply *completely fabricated* wire and spring assemblies in quantity. Get in touch with your AS&W salesman . . . take advantage of American Steel & Wire quality—and *price*.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

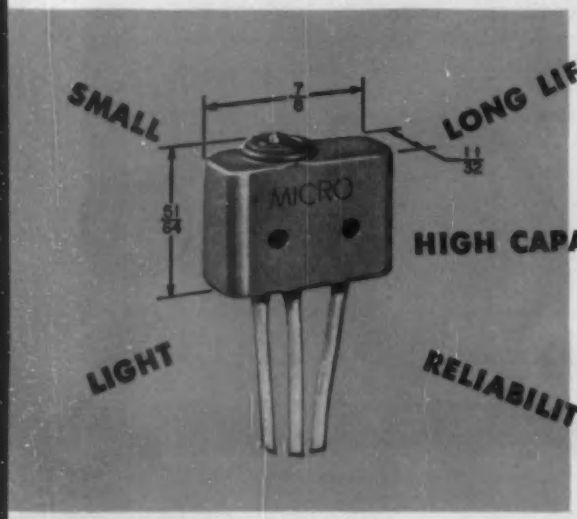
USS AMERICAN QUALITY SPRINGS

UNITED STATES STEEL

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

DO YOU NEED a really small switch– a subminiature–with LONG LIFE HIGH CAPACITY RELIABILITY ?

The newest Subminiature– a sealed switch that is environment-proof



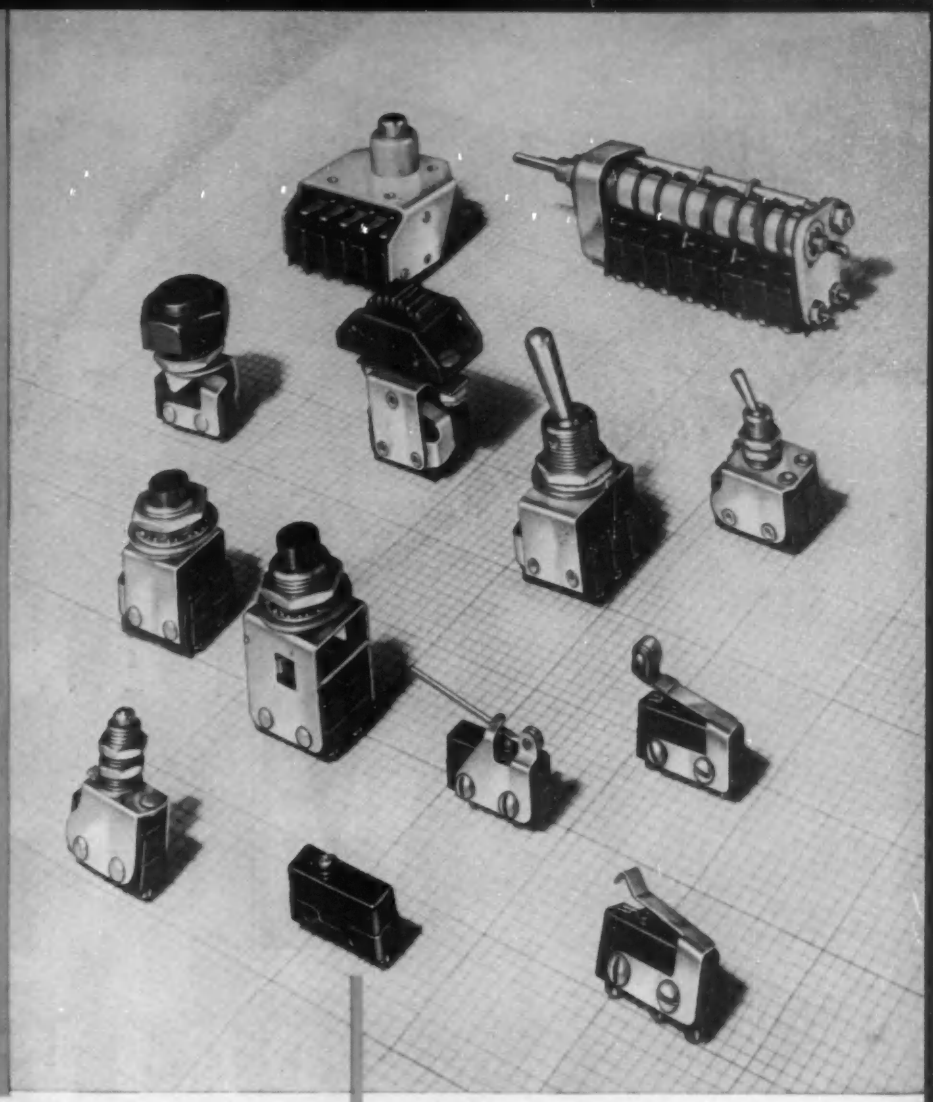
Environment-proof:
Switching element is completely sealed within the corrosion-resistant aluminum housing. The elastomer seal is bonded to both the pin plunger and the metal housing. The switch element is embedded in an epoxy casting resin which also seals the leads.

Light weight—small size:
Unit is 7/8" long and 11/32" thick. Weight is .03 oz.

Wide temperature range:
Designed to give trouble-free operation in a temperature range of from minus 65° to plus 180° F.

High electrical rating:
Electrical rating is 30 volts d-c, 2.5 amperes inductive, 4 amperes resistive. Maximum inrush, 15 amperes.

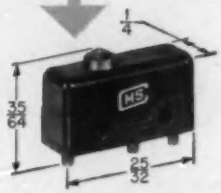
MICRO SWITCH has the subminiature switch — or assembly to meet *your* requirement



● Reliability of MICRO SWITCH products, whether ruggedly housed switches for control of heavy machinery or extremely small and delicately adjusted, has made these switches first choice of designers of equipment where component failure cannot be tolerated.

Ability of MICRO SWITCH engineering to design such a switch as the Subminiature has made possible streamlining of many hitherto cumbersome products. The MICRO SWITCH Subminiature is not only extremely small and light, but offers long life, high capacity and reliability unequalled in a switch of this size.

MICRO SWITCH goes further than that. We have developed an extremely wide variety of housings, actuators and assemblies of these small switches which permits them to be easily usable in a wide range of applications.



For full information on MICRO SWITCH Subminiature switches —write for Catalog 75 today

There are always new switches and new assemblies on the drawing boards and on test at MICRO SWITCH. To call MICRO SWITCH first is the short cut to the latest in switch development.

A complete line of snap-action and mercury switches

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

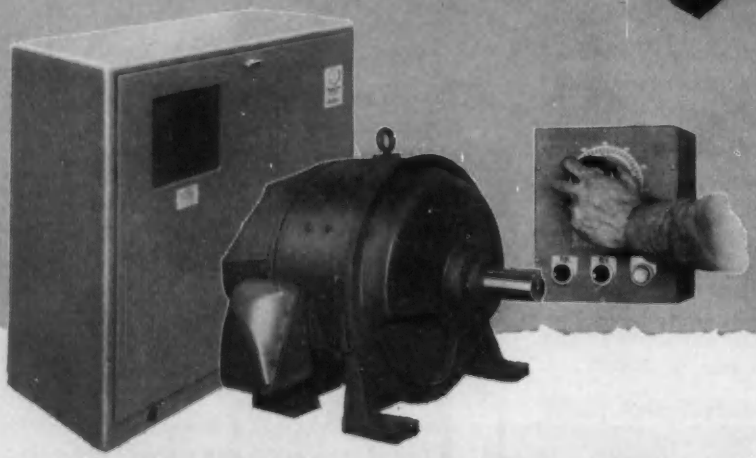
H HONEYWELL

117 Years of VARIABLE

A-C MOTORS • D-C. MOTORS • GEARMOTORS • ELECTRONIC CONTROLS • REGULATORS • M-G SETS • GENERATORS •

RELIANCE V★S DRIVE®

AND



D-1404

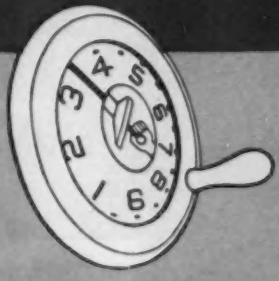
RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 10, OHIO

SPEED Drive Experience!

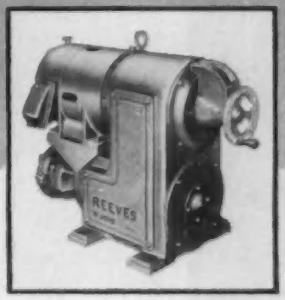
Announcing the combining of the engineering facilities and application experience of two great names in the power transmission field...

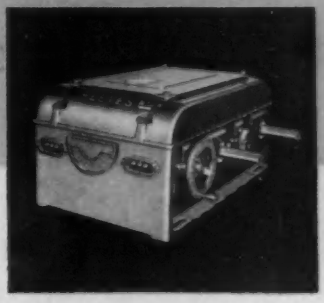
REEVES



Vari Speed Drives

VARI-SPEED MOTODRIVE • VARI-SPEED MOTOR PULLEY • FLEXI-SPEED DRIVE • VARIABLE SPEED TRANSMISSION





REEVES PULLEY COMPANY

COLUMBUS, INDIANA

DIVISION OF

RELIANCE ELECTRIC AND ENGINEERING CO.

MOTOR FACTS ON INDUSTRY'S
MOST PREFERRED "POWER PACKAGE"

Electrical System Fact—Only the new Life-Line "A" motor gives you the unsurpassed corrosion-resistant protection of exclusive new Bondar, Bondite and Mylar* insulations.

*Du Pont Registered Trade-Mark

FACT:

The new Life-Line A is the most corrosion-resistant motor on the market

The corrosive action of chemicals takes a heavy toll on conventional motors. The new Westinghouse Life-Line® "A" motor offers more protection against corrosive atmospheres than any other motor you can buy. How?

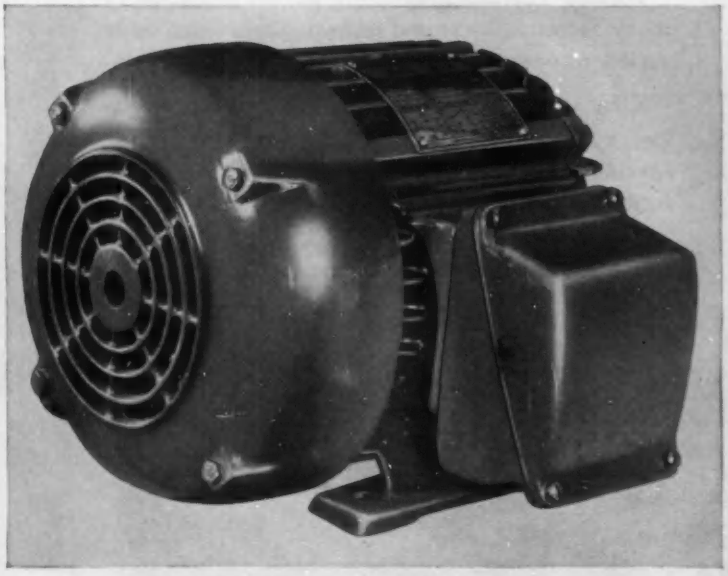
Because the combined improvements in insulation, housing and bearing design give unsurpassed protection against any contamination. It takes the right combination of such improvements in *all three systems*—electrical, mechanical and lubrication—to make the Life-Line "A" industry's most preferred power package.

Get all the facts by calling your Westinghouse sales engineer . . . *The Man With The Facts.*

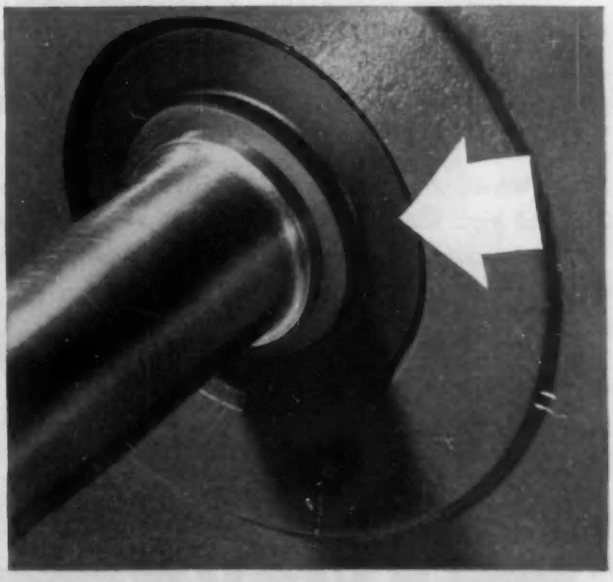
J-21881

YOU CAN BE SURE . . . IF IT'S

Westinghouse



Mechanical System Fact—New cast-iron frames and brackets utilize the finest grained castings with uniformly thick wall sections precisely fitted and sealed. Molded glass plastic cooling fans on totally-enclosed types are chemically inert.

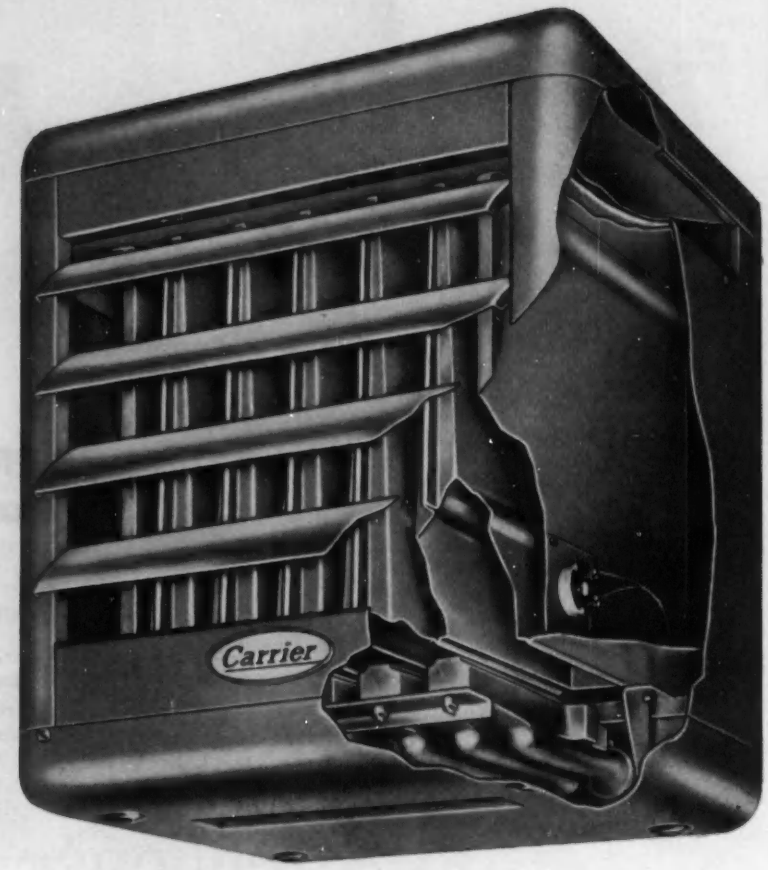


Lubrication System Fact—The new pre-lubricated Life-Line "A" bearing features a "4-way seal"—*two* seals on each side. Totally-enclosed types have additional neoprene flinger which assures bearing protection in any corrosive application.

Carrier's Experience Proves

KLIXON
Thermo Snap®
CONTROLS

are Dependable and Service Free



Carrier Unit Heaters have long been known for their heating efficiency and outstanding performance.

To insure accurate temperature control in their gas-fired unit heaters, Carrier uses Klixon Thermo-Snap Temperature Controls. Mr. Theodore F. Stone, Chief Product Engineer, writes: "We have used Spencer Klixon fan and limit temperature controls on our units for 6 years and have always found them to be dependable, service free and in accordance with specifications."

What's your temperature control problem . . . low and high limit controls, fuel delay switches, tube and rectifier cooling, fan switches, operating control . . . Klixon Thermo-Snap Controls are meeting the requirements for these and other applications in military and civilian products, daily.

Klixon Thermo-Snap Controls are available in many hermetically sealed and open types in a wide variety of operating temperature ranges.

Klixon Engineers, specialists in temperature control applications, can help you work out your specific application details. Write for their help or further information.

Typical Klixon Thermo-Snap Controls that can help you solve your Thermostat Control Problems

KLIXON

METALS AND CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
905 FOREST STREET, ATTLEBORO, MASS.

ALCUPLATE®

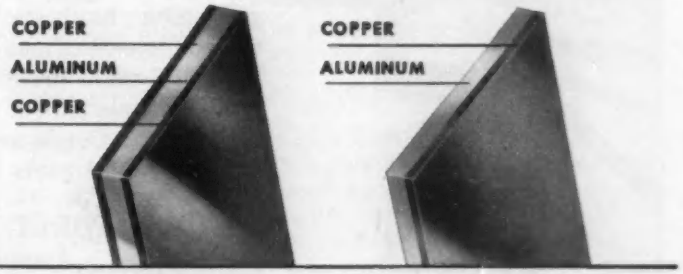
The Material of 1001 USES

Replaces Strip Copper or Brass at Savings up to 30%

Here's the Story:

Alcuplate was developed by General Plate to reduce the raw material costs for manufacturers using strip copper or brass.

A composite metal, Alcuplate is a solid layer of copper permanently bonded on one or both sides of less expensive aluminum. This combination has practically the same physical and electrical properties of copper . . . but reduces copper or brass costs by as much as 30%.



ALCUPLATE FEATURES

- Natural copper appearance
- High electrical conductivity
- Excellent heat dissipation
- Soft-soldering surfaces
- Easy fabrication
- Light weight

Here's how ALCUPLATE can be worked:

ALCUPLATE can be fabricated by stamping, drawing, spinning and forming. Its malleability permits its use in the manufacture of many parts from work-hardened rather than annealed or dead soft materials. The copper provides an ideal surface for soft-soldering operations and electroplated or other finishes.

A few typical products where ALCUPLATE is cutting fabrication costs

Heat transfer units • Electronic chassis and component cases • Electrical terminals Jewelry • Gift ware • Chafing dishes Water pitchers • Drain spouts

In what Sizes is ALCUPLATE Stock available?

In coils or cut lengths up to 1/16" thick by 13" wide and in a choice of thickness ratios and tempers.

For further information, write or wire

ALCUPLATE®
METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
15 FOREST ST., ATTLEBORO, MASS.

You save money

ON SMALL PRECISION PARTS

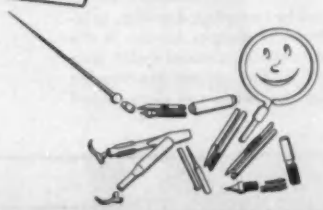
With almost 90 years of precision metalworking experience, Torrington has developed many automatic machines and techniques to produce small precision parts in quantities, large or small, at real savings to you.

This experience and equipment enables us to give you temper, hardness, finish and tolerances exactly to your specifications—*faster, better and for less* than you could produce them yourself. Why not send a sample part or blueprint for our quotation. Ask for our Condensed Catalog which shows the many types of parts we can make economically.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

TORRINGTON *SPECIAL* **METAL PARTS**

Makers of
Torrington
Needle Bearings



DU PONT

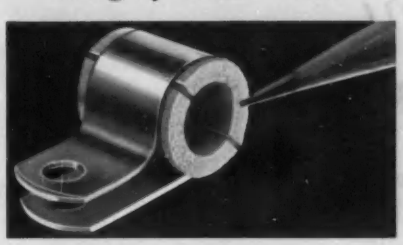
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 4 — 1955

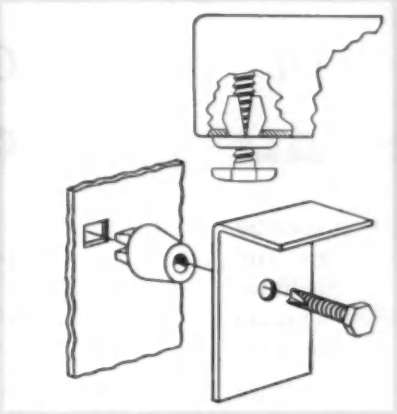
Design Engineers Develop New Grommets of "Zytel"* Nylon Resin to Reduce Breakage, Vibration

Clamp inserts of TEFLON® stop abrasion of aircraft wing hydraulic lines

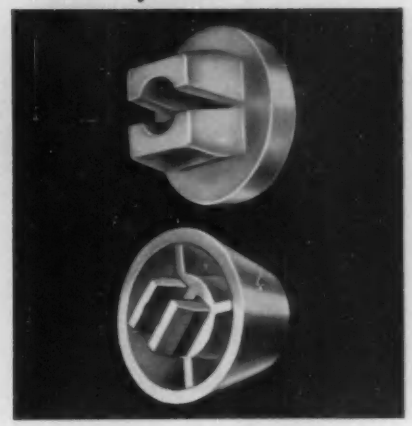


WHEN aerodynamic forces cause aircraft wings to undergo flexure in flight, wing hydraulic lines may undergo as much as six inches of movement. Aircraft manufacturers can now specify clamps with inserts of Du Pont "Teflon" tetrafluoroethylene resin to secure hydraulic lines that travel. Manufactured by Exacto Industries, Inc., Beverly Hills, California, with inserts of "Teflon" fabricated by W. S. Shamban & Co., Culver City, California, the clamps allow relative motion between hydraulic line and clamp, without abrasion. Natural slipperiness (self-lubricating) properties of "Teflon" tetrafluoroethylene resin allows hydraulic lines to move freely without being abraded.

Injection-molded "Zytel" eliminates extra parts; saves assembly costs



Top diagram shows how grommets of Du Pont "Zytel" nylon resin function as a leveling screw for a stove in the kitchen and (bottom) as a spacer between the inner liner and evaporator of a refrigerator.



Several types of "Plasti-Grommets". "Zytel" nylon resin is used for its resilience, strength, molding economy. (Grommets manufactured by Shakeproof Division of Illinois Tool Works, Elgin, Illinois.)

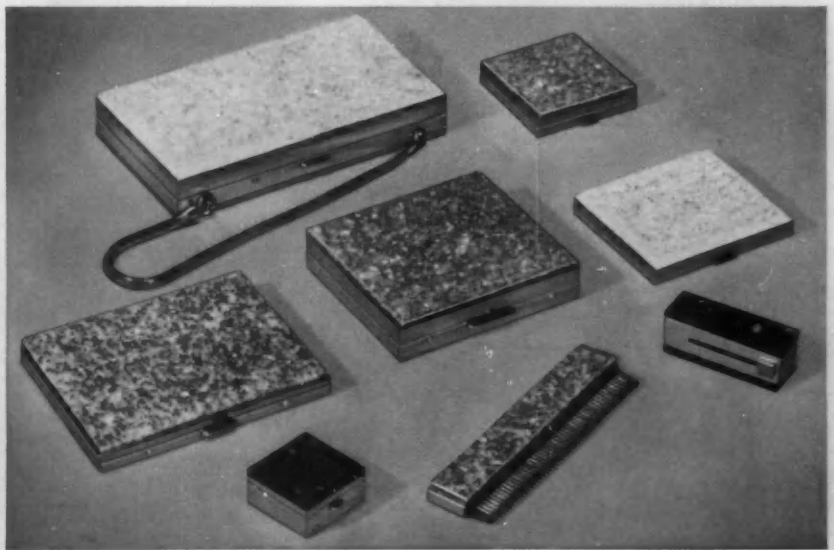
SELF-LOCKING GROMMETS, molded of Du Pont "Zytel" nylon resin, demonstrate how engineers—utilizing the combination of properties only "Zytel" offers—can improve existing products. These SHAKEPROOF Plasti-Grommets® have met with considerable success in the automotive, appliance and electrical industries. Because "Zytel" is resilient and absorbs vibration, the new grommets lock on tight—can't vibrate loose. Tests have proved the fastener strong enough to withstand a 500-600 lb. load. Moreover, "Zytel" nylon resin resists corrosion and has excellent dielectric properties. Grommets are available in any color.

Fewer Parts

Another advantage of "Zytel" is its moldability. One part of "Zytel" can often replace two or more parts in an assembly using conventional materials. As a result, there are fewer parts to handle in production; assembly time is considerably less. This moldability also means that intricate shapes can be produced efficiently and economically.

Can *your* operation be made more efficient and economical through the use of "Zytel"? Complete property information is available on this tough, wear-resistant engineering material. Simply fill out the coupon offered on the back side of this page.

OVER



These compacts carry decorative LUCITE® acrylic resin, in which colorful designs are embedded. "Lucite" is used today for many top-quality consumer items because it is long-wearing and easy to clean. It is also extruded into lighting fixtures of long-lasting beauty. For property and application data on Du Pont "Lucite", use the coupon on the other side of this page. Embedments of "Lucite" by Pearl Products, Inc., Glenside, Pennsylvania.

*"Zytel" is the new trade-mark for Du Pont nylon resin.

DU PONT
REG. U.S. PAT. OFF.

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 4 — 1955

Designers utilize properties of versatile "Zytel" nylon resin for bearing and for latch

THIS Shott chair has two 3/64"-thick bearings of "Zytel" nylon resin that permit smooth, quiet operation. The bearings of "Zytel" withstand abrasion and require no lubrication. (Chair manufactured by Balcrank, Inc., Cincinnati, Ohio.)

The Leco-Lon cupboard door latches of "Zytel", shown above, provide wear resistance, operate quietly, and hold door securely in place. (Latches made by Laboratory Equipment Corporation, St. Joseph, Michigan. Parts of "Zytel" molded by Hughes Tool & Manufacturing Co., Benton Harbor, Michigan.)

Connectors Utilize the Excellent Dielectric Properties of Du Pont TEFLON®

These connectors are insulated with "Teflon" tetrafluoroethylene resin—a material with exceptional dielectric properties and heat resistance. (Connectors manufactured by Industrial Products Company, Division of Danbury-Knudsen, Inc., Danbury, Conn.)

MOLDED "Teflon" tetrafluoroethylene resin is an excellent dielectric material—especially useful for miniature equipment where heat is often a problem. "Teflon" has a uniform dielectric constant of 2.0 in the frequency range of 60 to 10^9 cycles—insures that the connectors have a constant 50-ohm impedance. The high volume resistivity of greater than 10^{15} ohms cm. and low power factor of less than 0.0005 enable these connectors to carry RF power with practically no insertion loss.

Wide Temperature Range

"Teflon" has zero ASTM water absorption and a working temperature range that extends from −450° F. to 500° F. It resists corrosion from all chemicals except molten alkali metals and fluorine at elevated temperatures and pressures. Its ability to serve as a bearing, without lubrication (see front page—left column), is still another property that designers find useful.

Use the coupon on this page for complete property and application data.

Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"† nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 105, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
†"Zytel" is the new trade-mark for Du Pont nylon resin.

For draftsmen architects artists engineers

With the New Carter Squeeze Bottle it's much easier to fill your pens and instruments. You'll wonder why the Carter Squeeze Bottle didn't happen before.

You can leave the cap off the bottle all day without fear of spilling . . . or breaking.

Try Carter's Squeeze Bottle yourself . . . try it free of charge. Just fill out the coupon below.

Exclusive pinpoint applicator

- Speeds up pen or instrument filling.
- Prevents spilling or drying out
- Applies just the right amount of ink
- Uses up the last drop of ink

New, Electro-Polarized ink

- *No shaking necessary.* Electro-polarized to prevent settling. Uniform color throughout bottle . . . no thickening.
- *Completely opaque, uniformly black* . . . makes clean-cut lines and details without doubling back. No grey areas, no chipping or peeling.

Be Smarter Buy Carter's

Free Sample

mail coupon . . .

The Carter's Ink Company, Dept. E-5
Cambridge 42, Boston, Massachusetts

Please send me a FREE sample bottle of Carter's New Squeeze Bottle India Ink.

Name _____

Firm Name _____

Street Address _____

City _____ State _____

for those
"HARD-TO-REACH"
Places!

Lamson PLUG NUTS

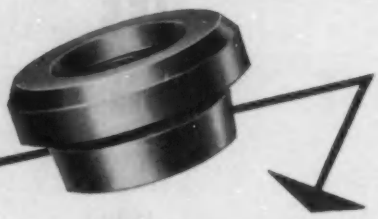
The advantages of Plug Nuts are many-fold. Both the designer and the production man will find they can solve many special fastening problems that cannot be solved in any other way.

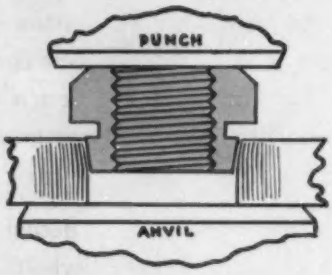
For instance, Plug Nuts are the ideal solution to "one way" fastening where it is difficult or impossible to work from both sides of the assembly.

Plug Nuts can often eliminate or simplify machining operations, improve the product, simplify design or reduce assembly, and hence, labor costs.

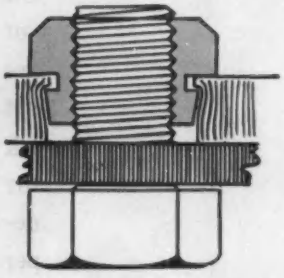
If you have an application where you think you might use Plug Nuts, send us the size required, or details of the application, and we'll be happy to send sample nuts for trial.

For additional detailed information send for the Lamson Plug Nut Brochure.





SEATING PLUG NUT IN HOLE



PLUG NUT SEATED AND BOLT TIGHTENED DOWN

PLUG NUT SIZES AND TYPES

Plug Nuts are available in sizes ranging from #4 to ½" diameter—fine or coarse threads. Plug Nuts work in copper, brass, magnesium, aluminum, steel, alloy steel castings (die and sand) and forgings.

U. S. PATENT NO. 2490594

HAVE ONE (or more) ON US!

Send us the details on any application where you think you could use Plug Nuts and we'll send you sample nuts to try out. No obligation, of course.

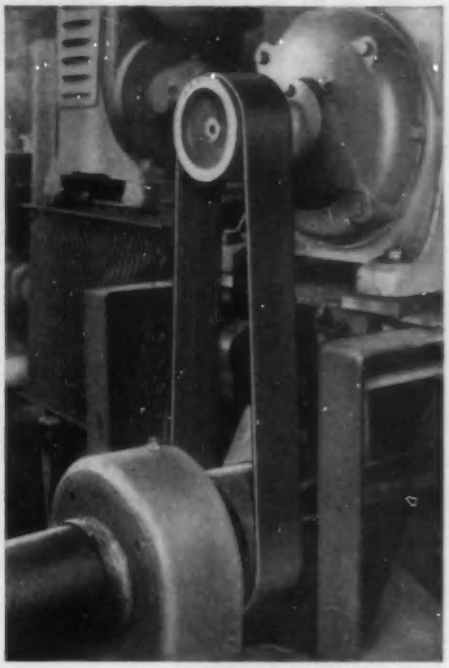
Lamson & Sessions

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

The facilities of our company are at your disposal to assist you with any fastener problem.

R/M *Poly-V*® *Drive*

PLUS R/M ENGINEERING SERVICE . . . . . SOLVES DIFFICULT DRIVE DESIGN PROBLEMS



(Belmont Co. installation photo.)

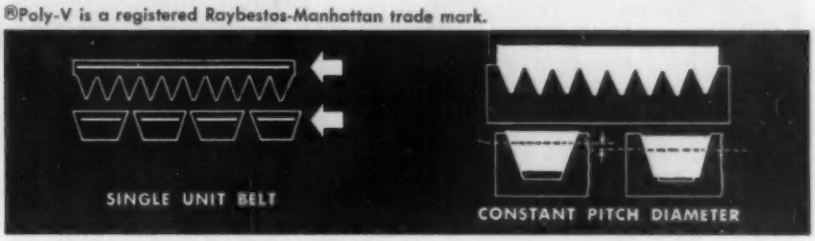
R/M ***Poly-V*** in metal working

Design engineers in many industries are discovering the outstanding design advantages of the R/M Poly-V Drive . . . and the service offered by the Raybestos-Manhattan engineers who developed this revolutionary and completely new concept of power transmission. Ideal for original equipment design applications, R/M's Poly-V Drive combines the high V-groove grip of V-belts with the strength and simplicity of flat belts in a *single* endless belt drive.

To help you solve difficult drive design problems with this exclusive, patented R/M development, Raybestos-Manhattan offers complete engineering data and service at no obligation. R/M engineers will gladly demonstrate advantages of R/M Poly-V Drive never before possible with ordinary V-belt drives. They are prepared to work personally with you and your staff . . . to study your drive design problems and make the proper recommendations.

Let R/M engineers show you why the R/M Poly-V Drive is proving the greatest advance in power transmission drive development since the multiple V-belt . . . for the improved design of both new and existing equipment. Write to Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J.

®Poly-V is a registered Raybestos-Manhattan trade mark.



NO MATCHING PROBLEMS — The Poly-V Belt is a single unit across full width of the sheave to give uniform pull, greater dependability and longer service because drive life is not limited to individual V-belt life.

CONSTANT PITCH DIAMETER — Poly-V Drive eliminates sinking of belt in sheave grooves . . . maintains constant pitch diameter and speed ratio at all loads for smoother, cooler drive operation . . . less wear on belt and sheaves.

ONLY TWO BELT CROSS SECTIONS — The entire field of heavy duty power transmission belt requirement is covered by two Poly-V Belt cross sections, instead of five multiple V-belt cross sections . . . simplifying drive inventories and increasing their interchangeability.

GREATER POWER CAPACITY WITH NARROWER SHEAVES — Because Poly-V Belt has higher horsepower capacity per inch of width, sheaves are narrower . . . you get more power in the same space as multiple V-belt drives, or equal power in less space.

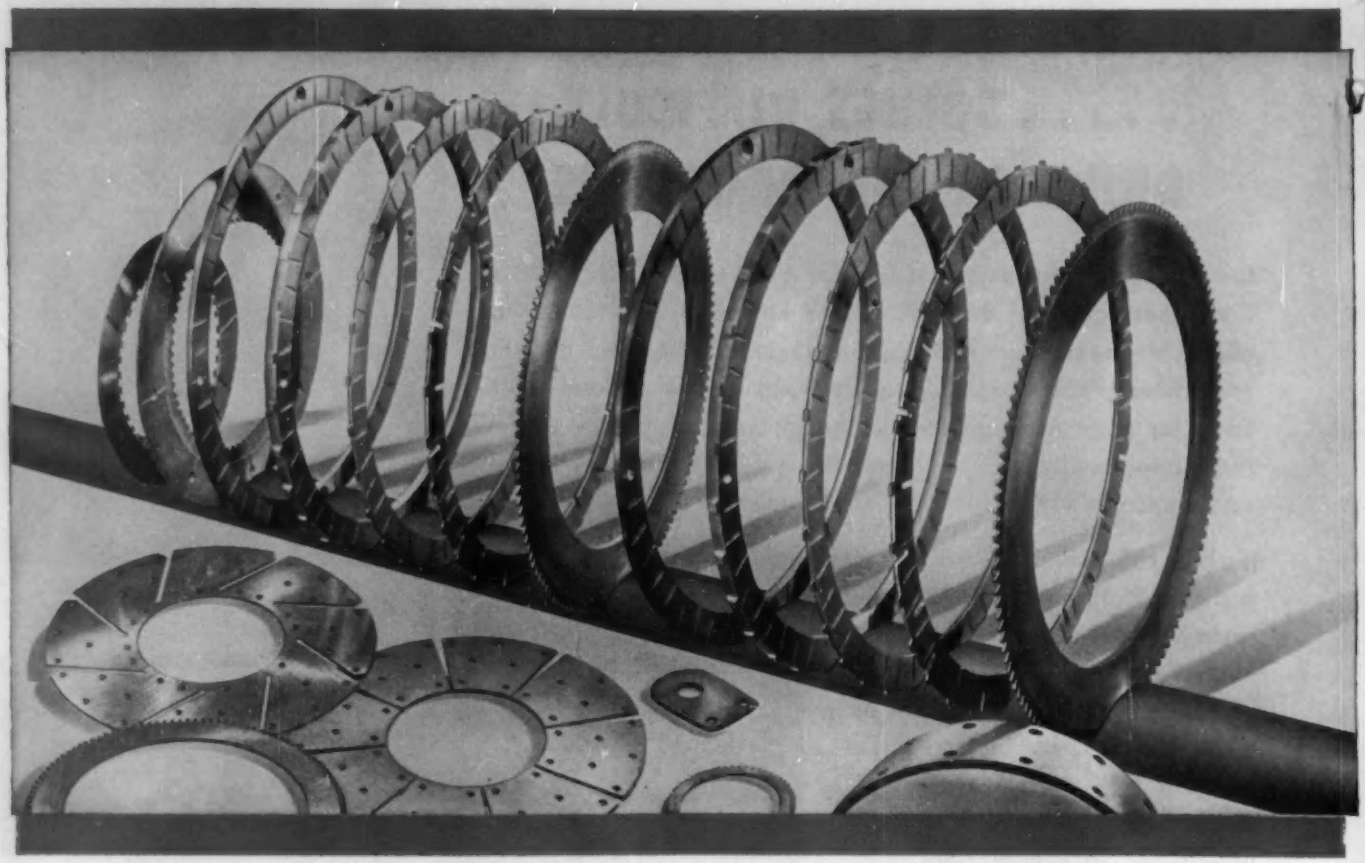
RM-537

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Bowling Balls

CALL ON R/M ENGINEERING SERVICE



FOR SPECIALIZED FRICTION REQUIREMENTS: SINTERED METAL

Do you have a friction material application involving high temperatures or close tolerances? If so, Raybestos-Manhattan sintered metal friction parts may be the exact answer.

Sintered metals will perform under severe conditions like these without appreciable increase in wear rate because of their high thermal conductivity and virtually indestructible bond. And R/M can provide sintered metal friction parts engineered to your specific requirements.

R/M sintered metal friction compounds are intended to *supplement* asbestos molded and woven lines—not *replace* them. That's why R/M, leader in both the asbestos and metal fields, is in an ideal position to help you. Unlike other makers, R/M works with *all* kinds of friction materials. So, when you consult an R/M engineer, you can be sure of a *completely unbiased* recommendation as to which are best for your application.

If you're looking for friction materials with greater output and durability, call R/M now. All the depth and breadth of R/M experience—the facilities of R/M's seven plants with their research and testing laboratories—are as near to you as your telephone.

Write for your copy of R/M Bulletin No. 500. It's loaded with practical design and engineering data on all R/M friction materials.

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS

ENGINEERED RUBBER HOSE

For general use with air, water, gases . . . special types for handling oil, acids, chemicals . . . non-spark high heat or non-contaminating constructions—R/M either has the hose or can make it for you. R/M hose constructions are made from natural or special synthetic rubbers—with strength members of long staple cotton . . . or super-strength synthetic cord . . . braided or solid wire reinforcement . . . always designed to provide maximum strength, plus flexibility without excess weight. R/M also makes flanged flexible pipe and rubber expansion joints. More than 60 years' manufacturing experience has gone into the development of R/M hose, V-belts, transmission and conveyor belts, and molded rubber products.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
GRegory 3-2000

PACKINGS, GASKETS ASBESTOS TEXTILES and "TEFLON"* PRODUCTS

If you are designing or making equipment in which any of the above might be used, don't hesitate to call on R/M's specialized engineering service for advice. R/M's line of packings and gaskets is complete in every respect, and in widespread use against air, gas, water, steam, oil, chemicals, solvents, food products and other hydraulic fluids. R/M also makes a wide variety of "TEFLON" products and an unusual number of asbestos textiles.

*Du Pont's trade-mark for its tetrafluoroethylene resin

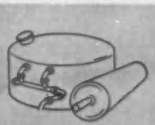
For booklet shown, or other data, write, phone or wire:

PACKING DIVISION OR ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Conveyor Belts



Rubber Lined and Covered Equipment

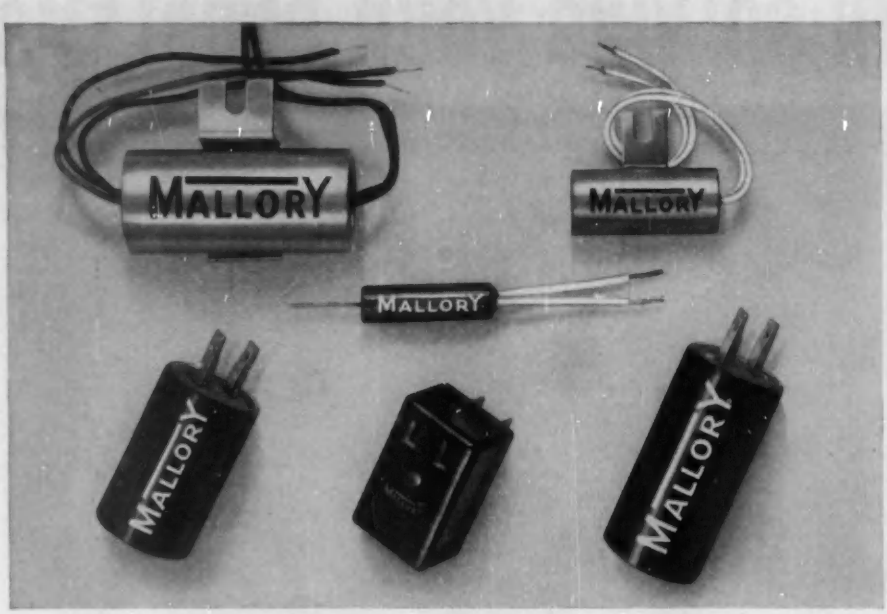
Sintered Metal Friction Elements

Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

R/M



Standard MALLORY filters

suppress radio noise . . . economically

If your product is one of the hundreds that can cause objectionable radio noise, Mallory can offer you an economical and effective solution to your noise-suppression problem. A standard line of Mallory filters is now available which covers a broad variety of products . . . power tools, electric shavers and appliances . . . which involve standard filtering requirements.

Included in this versatile family are a wide selection of voltage and ampere ratings, physical sizes and mounting arrangements. All are designed to provide broad band radio-frequency attenuation, under standard conditions of use, which is well in excess of that required under government specifications.

It will pay you to have a Mallory specialist investigate your product's filtering requirements to see whether one of these standard types will fill the bill. For if it can, you will save the cost of special designs . . . and gain the convenience of immediate delivery from stock. For a consultation, or for a copy of our Technical Bulletin, write or call Mallory today.

For special noise-suppression applications

Through years of experience in developing radio noise filters for manufacturers of military and civilian equipment, Mallory is well qualified to design filter units for your specialized needs . . . and to manufacture them economically. The latest in test facilities are used to assure filter performance in accordance with current specification requirements. Write for a copy of the Mallory Noise Filter Questionnaire which will help you outline your particular problem.

Expect more . . .

Get more from MALLORY

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

In Furniture it's...

REVERE

ALUMINUM

Light-weight, strong, rugged, weather-proof . . . and appealing to modern tastes . . . furniture of Revere Aluminum made by leading manufacturers brings new satisfaction to outdoor and indoor living.

If you are a manufacturer of home or office furniture, or accessories, you will find in Revere Aluminum Tube, Sheet and Extruded Shapes the fine surface finish and superior working qualities that smooth the flow of production and give extra eye-appeal to your products.

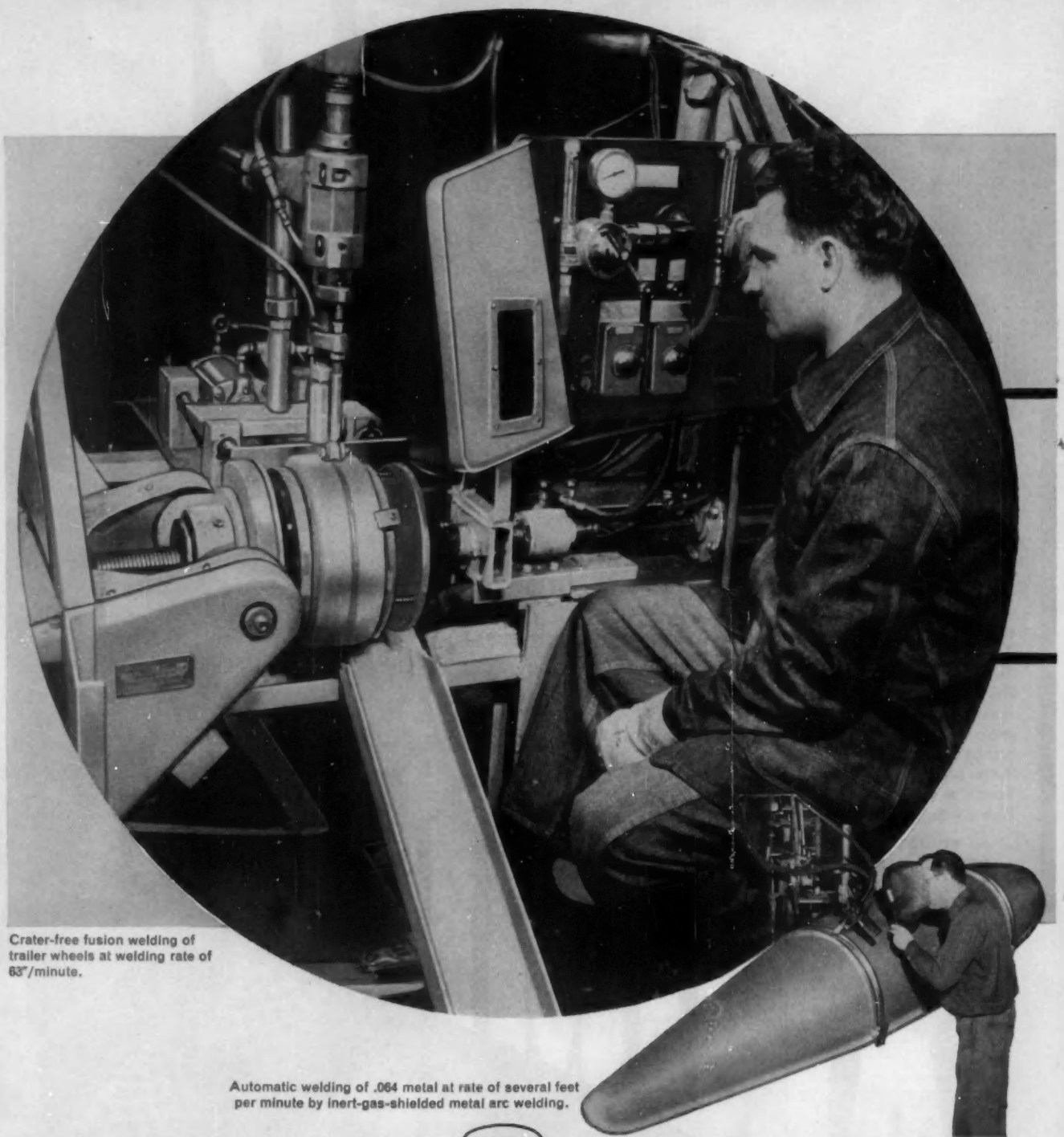
If you are a manufacturer of *anything* that is made or could be made better of aluminum, it will pay you to take advantage of Revere's exceptional experience in metals and Revere's Technical Advisory service. Revere Copper and Brass Incorporated, Founded by Paul Revere in 1801, Executive Offices, 230 Park Avenue, New York 17, N. Y.

REVERE KNOWS ITS A-B-C'S

ALUMINUM BRASS COPPER

when you design aluminum parts requiring

WELDING or



Crater-free fusion welding of trailer wheels at welding rate of 63"/minute.

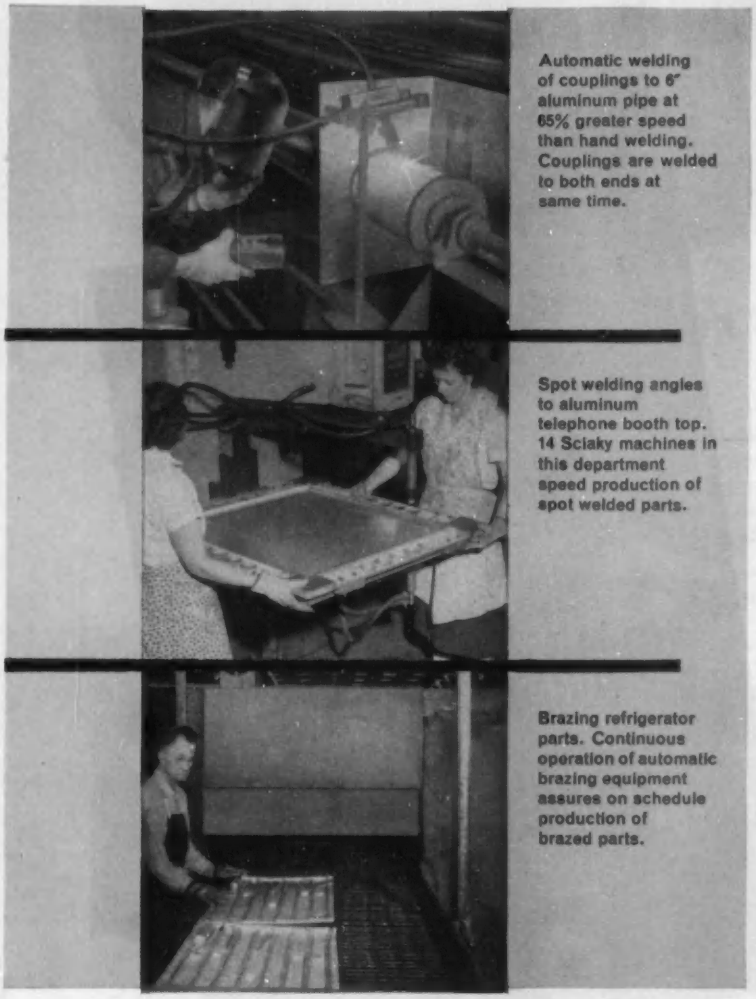
Automatic welding of .064 metal at rate of several feet per minute by inert-gas-shielded metal arc welding.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING

BRAZING...

There is no substitute for REYNOLDS experience and facilities



Automatic welding of couplings to 6" aluminum pipe at 65% greater speed than hand welding. Couplings are welded to both ends at same time.

Spot welding angles to aluminum telephone booth top. 14 Sciaky machines in this department speed production of spot welded parts.

Brazing refrigerator parts. Continuous operation of automatic brazing equipment assures on schedule production of brazed parts.

You can design any welded aluminum parts for your products with confidence because Reynolds Aluminum Fabricating Service can produce these parts and produce them efficiently and economically to your specifications.

Reynolds years of day-in, day-out welding and brazing on a wide variety of jobs—plus continuous developments and experimentation in the use of welding and brazing equipment and techniques—assure you the very highest quality welded and brazed parts.

Look at the photos on these pages. Note the variety of Reynolds welding and brazing operations. Reynolds offers welding equipment ranging from 30 to 800 amp., like the automatic fusion welding equipment shown on the opposite page capable of continuous welding up to 63 inches per minute and featuring built-in crater fillers that permit crater-free welding. Remember, too, Reynolds constant quality control minimizes "down time"—cuts your costs.

For full details on these operations and on the many other services offered by Reynolds Aluminum Fabricating Service, call your Reynolds office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.*

FREE:

Write for your copy of the new 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

See "Mister Peepers", starring Wally Cox, Sundays on NBC-TV.

FABRICATING SERVICE

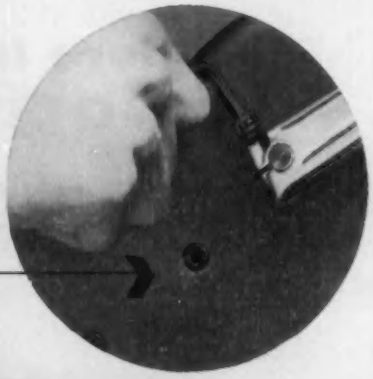
ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

P-K *means* OK

TRADE MARK.
REG. U.S. PAT. OFF.

in the package

in assembly



in product performance

P-K means OK right down the line. *When you buy* P-K Socket Screws, it means OK for guaranteed quality and tolerance gaged to highest standards. *On the job,* it means OK for advanced design features that speed the job, prevent errors, like SIZE-MARK on P-K Cap Screws. *When you sell* your product, it means OK for lasting strength, dependable performance proved in millions of assemblies.

Get samples, information from your P-K Distributor, or write Parker-Kalon Division, General American Transportation, Corporation, 200 Varick St., New York 14.

make planned assembly savings pay off

PARKER-KALON SOCKET SCREWS

IN STOCK—see your nearby P-K Socket Screw Distributor

Cleveland cooling tower drive on test at the factory, to insure quiet, smooth running.

10 specific benefits for you with a CLEVELAND worm gear drive

WORM GEARING—the universal drive—affords exceptional advantages for practically all power transmission jobs. When it's *Cleveland* worm gearing you also get the extra benefits of 42 years of experience of specialists in this field. See how these Cleveland advantages can improve your operations and reduce maintenance:

1. **COMPACTNESS**—saves space.
2. **RIGHT-ANGLE CONSTRUCTION**—saves space.
3. **MINIMUM MOVING PARTS**—reduces maintenance.
4. **SMOOTH**, uninterrupted torque flow.
5. **QUIET RUNNING.**
6. **HIGH** shock load resistance.
7. **ENCLOSED** in oil bath—assures safety and minimum maintenance.
8. **CORRECT** gear alignment is maintained.
9. **LONG LIFE** from steel worm on bronze gear.
10. **EFFICIENCY** maintained throughout life of the unit.

Whenever you have a power transmission problem, get the full Cleveland story. Then you'll specify Cleveland worm gear drives. Write for helpful technical advice and ask for Catalog 400. The Cleveland Worm and Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

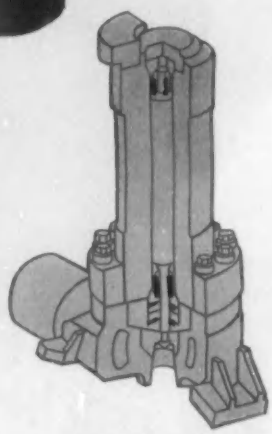
CLEVELAND
Worm Gear
Speed Reducers

GRAPHITAR® . . . the versatile

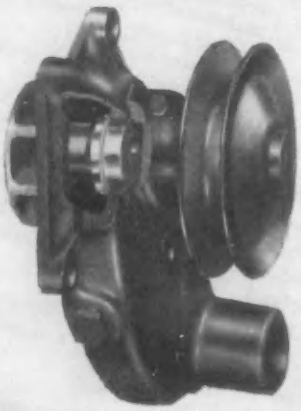
(CARBON-GRAPHITE)

insuring the performance

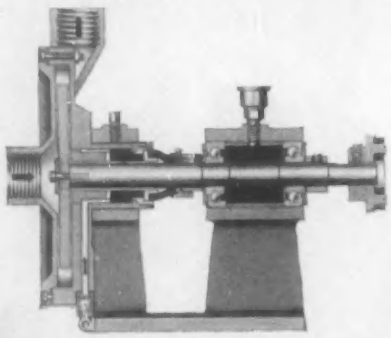
There are literally hundreds of difficult applications where the only completely successful material is GRAPHITAR. It can be used where water and steam are present . . . in fact, where *only* water and steam are present . . . because it does not need oil lubrication. It can be used where the temperatures are those of a toaster or the pressures those of a pump. GRAPHITAR is a versatile engineering material produced from carbon-graphite powders, compacted under terrific pressure and fused at heats near 4500° F. It can be formed in relatively complicated shapes and ground to tolerances as close as .0005″ for seals, bearings, vanes, piston liners and many other parts. GRAPHITAR is lightweight, strong and durable, chemically inert, and virtually unaffected by high speeds, high pressures, or temperature extremes. Write today for our illustrated 64-page GRAPHITAR catalog.



These GRAPHITAR bearings are part of the hermetically sealed pumps in our new atomic-powered submarine NAUTILUS. They must withstand high speeds, high temperatures, high pressures, and must operate for indefinite periods of time without maintenance and with radioactive hot water as the only lubricant.



GRAPHITAR is a standard part of this latest type automotive water pump seal. This seal will not leak hot water, cold water, or any type of antifreeze; the wear resistance and chemical resistance of GRAPHITAR insure a seal that will last for the life of the car.



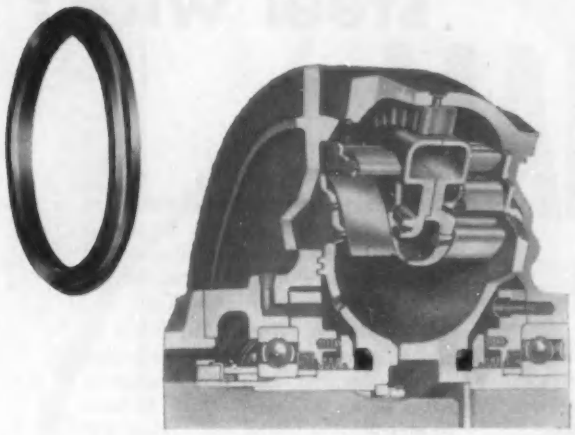
This GRAPHITAR block seal is in a centrifugal type pump that must handle a variety of chemicals and acids. GRAPHITAR resists virtually all chemicals; such potent reagents as Citric and Hydrocholoric acids have no effect on GRAPHITAR.

OUR 101ST YEAR

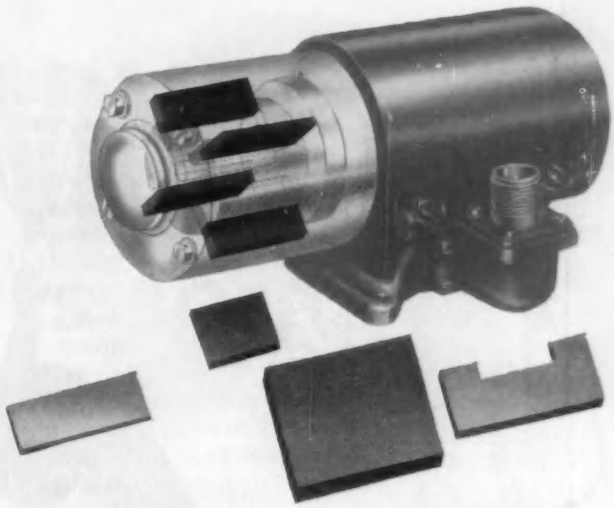
THE UNITED STATES

material that is

of hundreds of products



Operating at temperatures up to 350° and 400° F., under pressures of 100 psi and rotating at 1000 feet per minute, GRAPHITAR seals in this industrial torque converter hold a static head and will not gall or leak hot oil. The lapped flat surfaces do not warp or distort.



Rotary pumps, compressors, air motors, vacuum pumps and similar machines equipped with GRAPHITAR vanes function efficiently, give long service, and require little or no maintenance. 25,000,000 of these vanes are now operating in automobiles, in aircraft, in farm equipment, and in household appliances.

These mechanical seals rotate with the shafts of such units as rotary pumps, autoclaves, blowers, etc., to provide a pressure-tight rotary seal. The GRAPHITAR gland insert is ideally suited for this use because it is self-lubricating, chemically inert, and highly resistant to wear.

This pump is essentially an electric motor built around a rotor supported by two GRAPHITAR bearings. It can pump almost any liquid, and the liquid itself is the only lubricant for the GRAPHITAR bearings. The pump is leakproof and needs no oiling.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

Do you store and handle steel wire?

The storage and handling of steel wire coils is an art all its own. So if you are faced with the problem, why not take advantage of the free advice offered by American Steel & Wire?

Your AS&W representative will be glad to go over your present or future warehouse and handling facilities. After sizing up the situation, he may be able to offer sound advice that will save you many thousands of dollars every year.

It's a big problem, involving the most economical size coils to order, the most efficient in-plant handling methods, and how to store the coils until they are used. If you contemplate the design of new wire fabricating equipment, your AS&W representative can give you valuable design information. That way, you can be sure that the machinery you design can be served with approved handling equipment, and use lower cost, standard steel wire coils.

Want to take us up on the offer? Just call your local AS&W salesman.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS AMERICAN MANUFACTURERS WIRE

AMERICAN MANUFACTURERS WIRE

AMERFINE—*High quality fine wire.*

AMERSPRING—*music steel spring wire.*

AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire.*

USS

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

FASTER PRODUCTION? FINER PRODUCTS?

MARVINOL VR-22

GIVES BOTH!

New Marvinol® VR-22 is a straight polyvinyl chloride resin *especially designed for dry blend extrusion* for both electrical and non-electrical applications. Easily calendered or molded, too, VR-22 gives you and your customers these important benefits.

PRODUCTION BENEFITS—better dry blending in all types of heated mixing equipment • uniform, free-flowing mixes • rapid drying time—allows shorter mixing cycles • high extrusion speeds • shorter Banbury cycles • smooth, free-rolling bank for calendered film and sheeting • allows reprocessing of your film scrap material without color change.

PRODUCT BENEFITS—gives product exceptionally high gloss • provides excellent electrical properties • produces gel-free film and sheeting • offers excellent heat, light, and color stability.

Marvinol VR-22 has already been used to advantage in... tough, glossy garden hose...efficient, attractive wire insulation... smooth, tough pipe and tubing...strong shoe welting and upholstery binding...heavy gauge press polished sheet.

Why not profit with Marvinol VR-22 for...

- window channels and panel trim?
- tough upholstery?
- primary insulation and cable jackets?
- window shades?
- electrical tape?

Why not investigate new Marvinol VR-22? And think of it in terms of the *easier production* and *extra sell* it can give *your* products. Find out more about this important new vinyl resin by writing on your letterhead to the address below.

Naugatuck Chemical

Division of United States Rubber Company

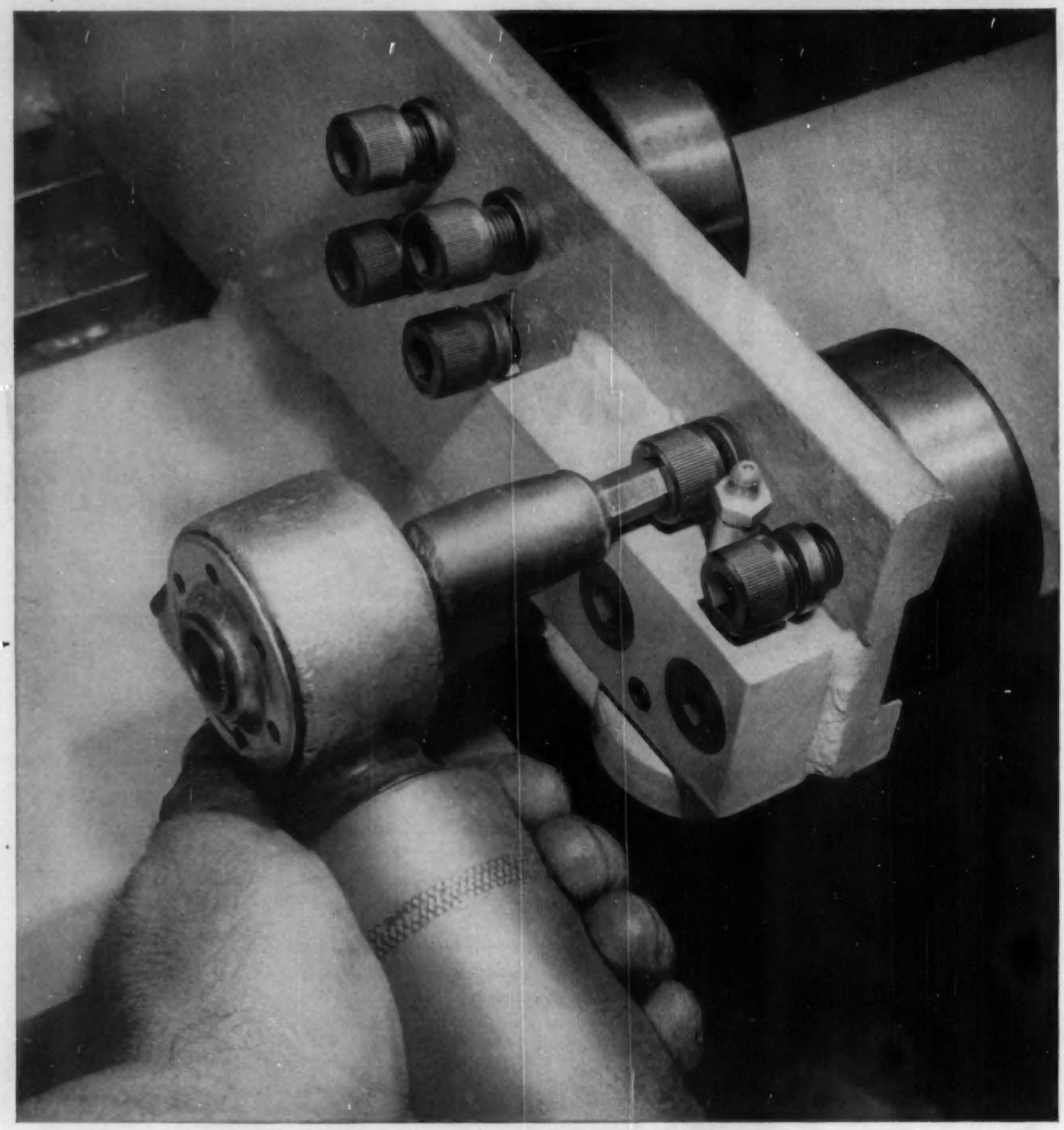
Naugatuck, Connecticut

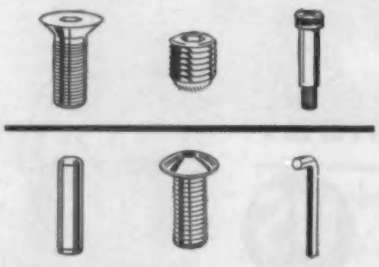
US RUBBER

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia
IN CANADA: Naugatuck Chemicals, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

SEAL OF QUALITY · VINYL FILM · STANDARD OF QUALITY

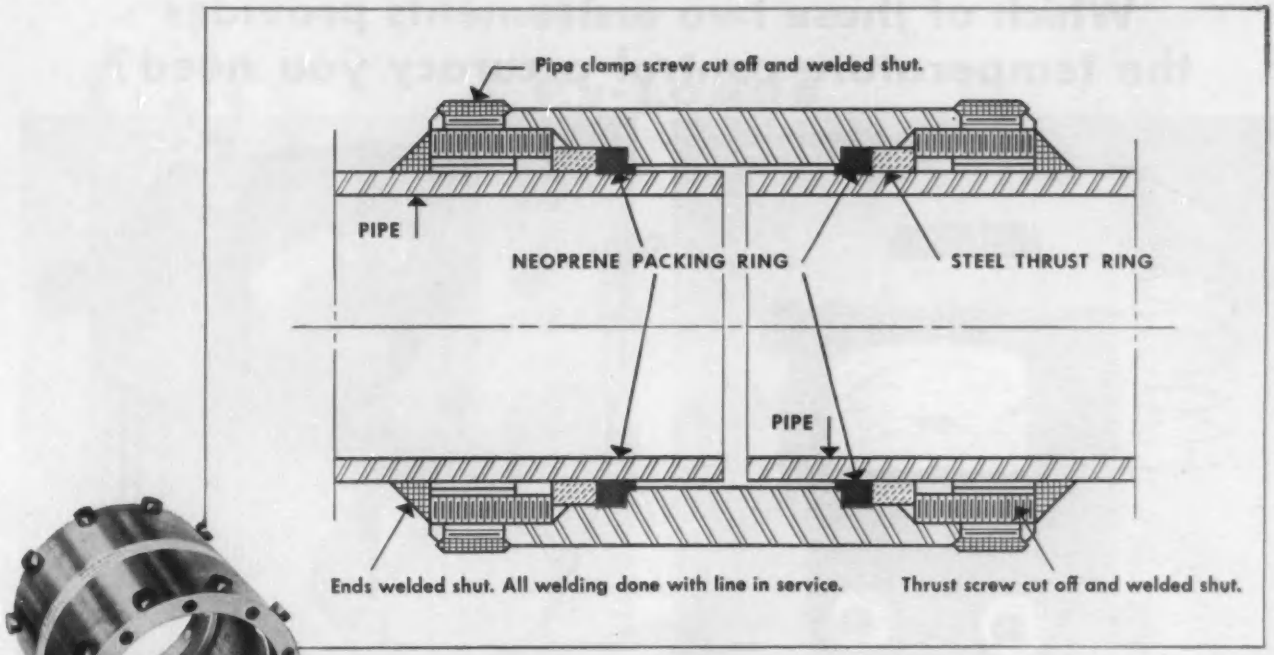
Naugatuck Chemical is an original sponsor of the new Vinyl Film Standard of Quality Program.

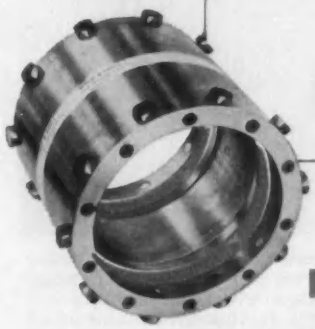




UNBRAKO SOCKET HEAD CAP SCREWS provide additional safety and increased efficiency on industrial lift trucks. Sixteen of them are used to fasten the side thrust fork carriage rollers which reduce the stresses caused by off-center loading. These standard UNBRAKOs have heads forged for strength, and sockets of uniform depth and size for strength and maximum torque in wrenching. Fillets and threads are formed to provide continuous grain flow throughout the screw. For the UNBRAKO story, see your authorized industrial distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION SPS JENKINTOWN, PENNSYLVANIA


Pipe clamp screw cut off and welded shut.
PIPE
NEOPRENE PACKING RING
STEEL THRUST RING
PIPE
Ends welded shut. All welding done with line in service.
Thrust screw cut off and welded shut.



Packing ring of DU PONT NEOPRENE

has high tensile strength...resists oil and heat

A new design in pipe couplings features two packing rings of neoprene, Du Pont's chemical rubber. Developed primarily for use when replacing sections on cross-country pipelines, it permits sections to be joined quickly—even under conditions of misalignment—and returned to service under full pressure. Time-consuming cleanup and welding can then proceed with the line in service.

Here's how the coupling works: Longitudinal bolts in the ends of the coupling are mechanically tightened, exerting pressure on two steel thrust rings. These rings, in turn, force the resilient neoprene packing rings against the pipe wall. Result: a positive seal at line pressures up to 2000 psi.

The inventor of this coupling specified neoprene because no other elastomer offered the *balanced combination* of properties he needed. Neoprene's low compression set assured lasting resilience . . . its high shear and tensile strength meant long service. And because neoprene is resistant to deterioration from oil, gasoline and heat, the line can be kept in use while welding is done.

Neoprene can be used in hundreds of industrial products. When your plans call for a resilient material, why not try it? It may be the key to a successful design.

Remember, of all resilient materials, only neoprene has balanced resistance to:

- Oils, solvents, most chemicals
- Permanent distortion
- Air and gas diffusion
- Abrasion, cutting, chipping
- Low-temperature stiffening
- Sunlight and weathering
- Oxidation
- Heat

NEOPRENE

The rubber made by Du Pont since 1932

DUPONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

READ "THE LANGUAGE OF RUBBER"—A series of technical articles now appearing in each issue of the free NEOPRENE NOTEBOOK. Mail this coupon . . . add your name to the mailing list today!

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division PE-5,
Wilmington 98, Delaware.

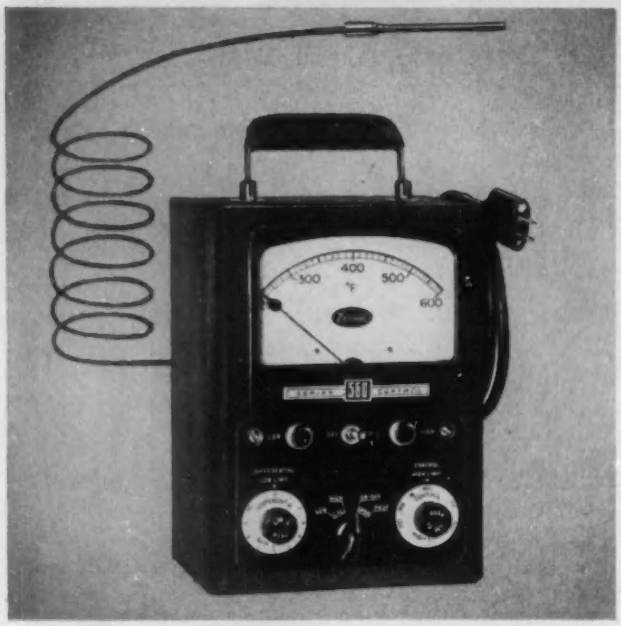
*Name*_____ *Position*_____

*Firm*_____

*Address*_____

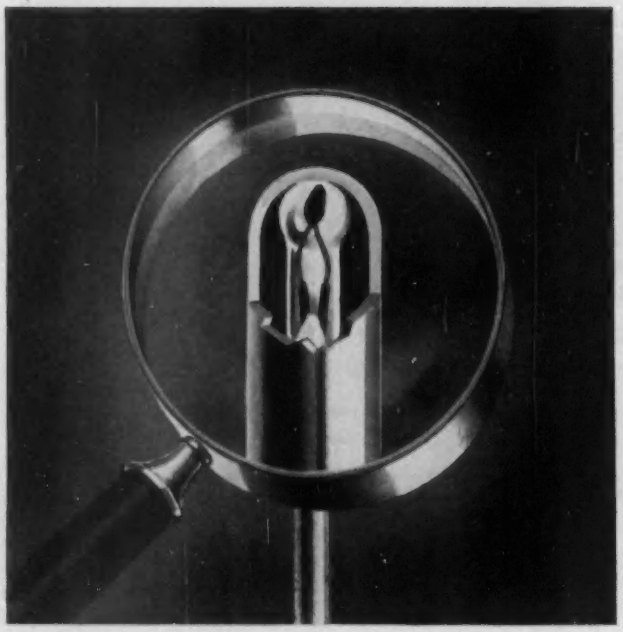
*City*_____ *State*_____

Which of these two instruments provides the temperature control accuracy you need?

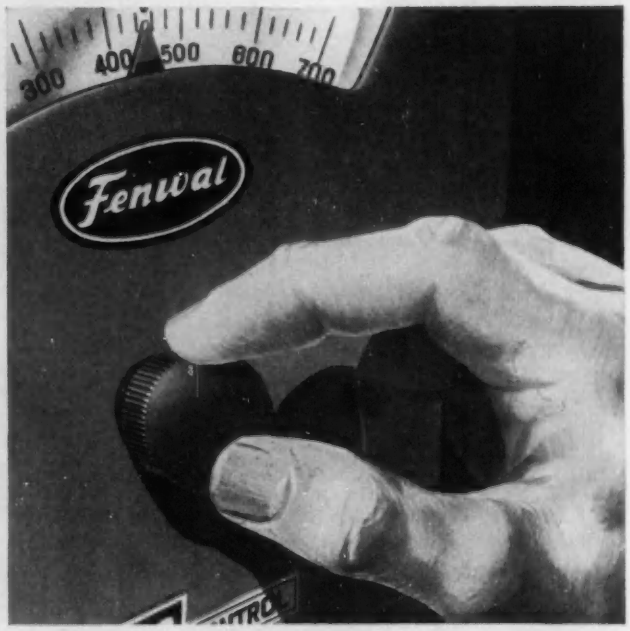


1. IT'S ELECTRONIC! The new Series 560 applies the thermistor principle in temperature indicator controls with heretofore unattainable accuracy over a scale range of 200° to 600°F. It's the *only* instrument that provides the three major control modes — (1) on-off (2) proportional (3) adjustable differential — all at the flip of a switch. Wide range of use for general laboratory, processing, molding or packaging applications.

2. IT'S MECHANICAL! The new Series 540 indicating controller combines low cost with high accuracy over a temperature range of 100° to 700°F. Temperature changes are transmitted by a bulb and bellows to an indicator control. Instrument features on-off control . . . adjustable differential . . . ambient compensation. May be flush or surface mounted. Capacity of 15 amps at 115 volts.



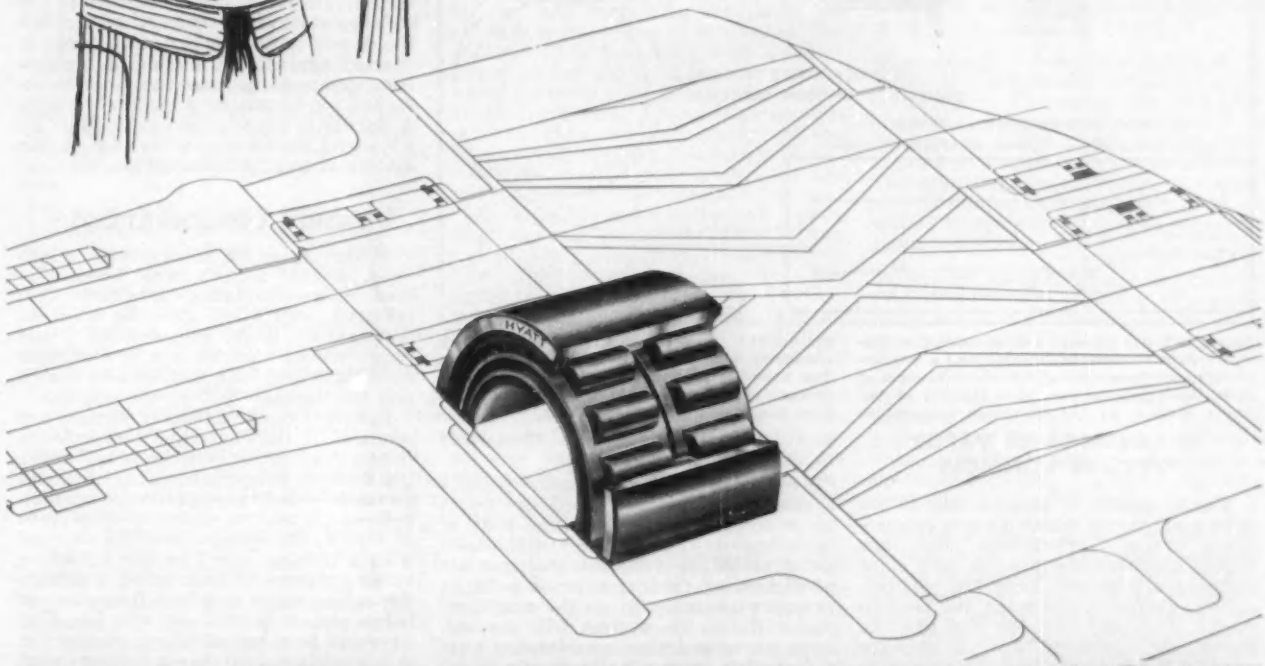
3. SIMPLICITY ITSELF is secret of Fenwal's Series 560 — accuracy, sensitivity and ruggedness. The thermistor's high resistance change permits operation with any length of lead wire up to 200 feet without affecting signal strength or accuracy. Thermistor is hermetically sealed in glass for stability; encased in stainless steel for ruggedness. No complex circuitry; maintenance is easy.



4. EASY "SET" AND "CHECK" OPERATION is a feature of Fenwal's Series 540 which is accurate to within 2% over the 100° to 700°F range, including the effects of ambient temperatures. Send for FREE NEW BULLETINS, MC122 on the Series 540, MC123 on the Series 560. Both contain full data you should have. Write to **Fenwal Incorporated, 25 Pleasant St., Ashland, Mass.**

Fenwal Controls Temperature... *Precisely*

How Hy-Loads can help you...



PROVIDE HORIZONTAL FLOAT

HY POTENUSE, the sage of the slide rule, SAYS:

Ever have herringbone gears bind on you because the shaft couldn't float freely to permit the gears to mate properly? It can happen when you use laterally locked bearings—*but it can't happen here!*

The designer of this pump assembly has made doubly durn sure *he* won't get into trouble—by specifying HYATT A-6200-T Cylindrical Roller Bearings. *First*, he knows they'll provide plenty of lateral float so the herringbone gears can mesh freely (and to take care of possible shaft expansion in case hot liquids are pumped). *Second*, a single bearing with two rows of rollers gives him maximum load capacity in minimum space—without any possibility of overload on one bearing or the other that might creep in if he used two separate bearings.

If you haven't a HYATT General Catalog No. 150 handy, better send for yours pronto, brother—it'll save you a heap of time and headaches! *Remember, you can't go awry when you specify—*

your COMPLETE LINE of cylindrical roller bearings

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

(*Advertisement*)

Vapor Pressure Bellows Devices for Remote Control of Temperature

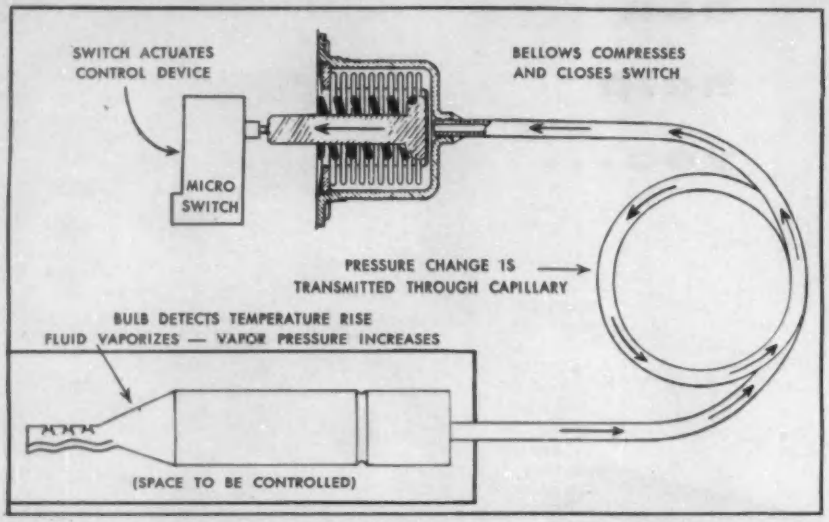

SWITCH ACTUATES CONTROL DEVICE
BELLOWS COMPRESSES AND CLOSES SWITCH
MICRO SWITCH
PRESSURE CHANGE IS TRANSMITTED THROUGH CAPILLARY
BULB DETECTS TEMPERATURE RISE
FLUID VAPORIZES — VAPOR PRESSURE INCREASES
(SPACE TO BE CONTROLLED)

Figure 1. Vapor pressure bellows assemblies provide remote temperature control over a temperature range from about −40F to a maximum of 500F, depending on the vapor pressure of the filling medium at the maximum temperature encountered. They offer the advantage of high sensitivity and relatively long bellows stroke. This principle may be applied using increase or decrease of the vapor pressure to transmit the force to actuate a control mechanism.

ADVANTAGES OF VAPOR PRESSURE CONTROLS

Vapor pressure bellows assemblies offer a number of advantages in temperature control applications. They are highly sensitive and provide very close temperature control. They are positive-acting, simple in operation and easy to install. They can be made "fail-safe" to protect the equipment to which they are applied. When spring loaded, vapor pressure assemblies can be adjusted within very close limits. Bellows stroke is relatively long, making it easy to actuate switches or valves without elaborate linkage. They can be used for temperatures as low as −40F or as high as 500F and not affected by ambient temperatures outside of the chamber to be controlled. As a result, vapor pressure bellows assemblies are widely used as temperature controls for refrigerators, ovens, appliances, hot water storage tanks, processing equipment, wax pots, acid baths and numerous specialized industrial applications.

Proved in use. Vapor pressure bellows systems have long been used as temperature controls. Hence, a large body of performance and design data has been accumulated. This data assures accurate prediction of performance of a vapor pressure assembly, given the conditions under which the system will operate. And, since the design considerations are well known, it is usually simple to design a vapor pressure bellows assembly that will meet service requirements satisfactorily. The Clifford Manufacturing Company has a broad range of standard thermostatic assemblies engineered for quality, economy and reliable operation. These can be furnished to meet a wide variety of temperature control applications or readily adapted in design to meet special requirements. Important savings can be achieved by utilizing a standard design. A sketch showing controlling factors and dimensions for your application will enable Clifford to advise you how a standard design will meet your requirements.

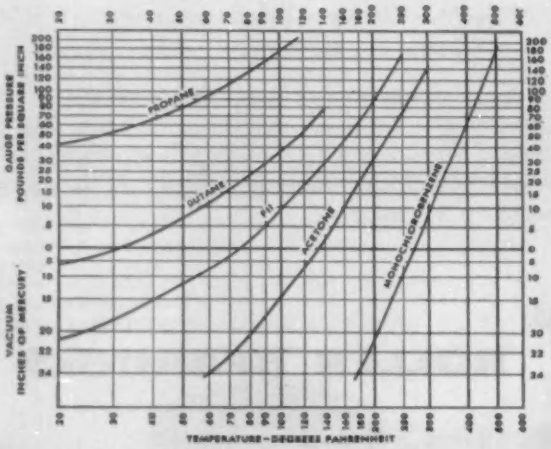


Figure 2. Vapor pressure-temperature curves for a few of the more common fluids used in vapor pressure bellows assemblies.

Operating principle (Fig. 1). When a confined liquid is heated, a vapor pressure is generated in the space above it. Vapor pressure as a function of temperature varies according to definite laws and so may be predicted accurately (see curves, Fig. 2).

Vapor pressure increases in an exponential curve. Butane, for example, from 30F to 40F changes pressure only 3 psi, but from 90F to 100F changes 9 psi. Therefore, a switch that operates with a .010 movement would have ⅓ the *temperature* differential at the higher end of the curve than a control operating at the low end of the curve.

The thermal fluid is stored in a temperature sensing bulb which is placed in the space to be controlled. The bulb is connected to a bellows cup assembly by a capillary tube. As the temperature of the bulb rises, vapor pressure in the bulb increases and is transmitted through the capillary to the cup. The force is exerted against the outside of the bellows, compressing it and moving the attached rod to actuate a switch or valve. A spring is usually incorporated as an adjusting means to provide an accurate setting of control temperature.

DESIGN CONSIDERATIONS

In the design of vapor-pressure systems, several factors must be considered: temperature range to be controlled, required sensitivity and the ambient temperature limits encountered. These requirements must be met by the right combination of bulb and bellows design and the thermal "fill" of the system.

Different combinations of factors are required if the controlled temperature is below, above, or *both* below *and* above the ambient temperature at the bellows.

Controls — bulb temperature lower than bellows. A control designed to operate at zero F, for example, must be charged with a thermal liquid having an active vapor pressure at that point, although the boiling point may be either above or below zero F. Methyl chloride (see Fig. 2) would be a logical filling medium for this application; it has a boiling point just under minus 10F and a vapor pressure of 3 to 4 psig at zero F. When used in refrigeration equipment, it functions satisfactorily, but since it has a vapor pressure of 150 psi at 120F, it would produce excessive pressure when subjected to high temperatures such as during shipment or storage of the unit. To design the assembly to withstand the overpressure would unnecessarily reduce the sensitivity of the control.

This is easily avoided in Clifford units through a calculated limited filling of the system. A volume of volatile liquid is selected so that it will be completely

Figure 3. Clifford vapor pressure bellows assemblies are widely used in refrigerators. They provide positive action for the close temperature control essential to modern refrigeration.

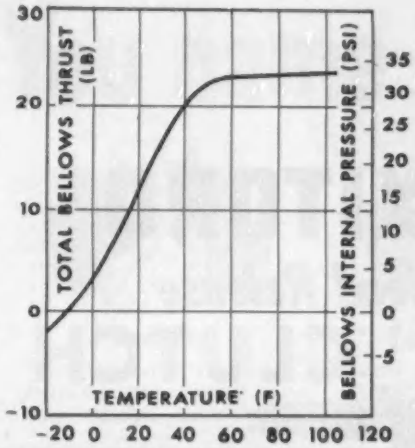


Figure 4. Temperature vs. thrust curve for a 1⅛" bellows with limited fill of methyl chloride. Full vaporization is complete about 50F. Only negligible gaseous expansion occurs above that point.

vaporized at a temperature just above the maximum desired control temperature. Beyond that point, only gaseous expansion takes place. Figure 3 shows the limited fill curve for a typical filling medium used in refrigerator temperature controls. Standard Clifford vapor pressure assemblies already engineered are obtainable for control of temperatures as low as −40F.

Ambient temperature has no significant effect on low temperature controls, because the volatile liquid is wholly contained in the bulb, which is usually quite small and located in the chamber to be controlled.

The pressure throughout the entire thermostatic assembly is always governed by the bulb temperature.

Controls—bulb temperature higher than bellows. For controls designed to operate at temperatures higher than the ambient temperature at the bellows, the assembly is almost completely filled with liquid. The vapor pressure is generated at the hottest point (the bulb) and transmitted to the bellows cup by the hydraulic action of the filling medium. The bulb is designed to trap the vapor within it, so that only *liquid* is forced out of the bulb and into the capillary and bellows cup. Over-temperature protection can be provided by limiting bulb size. Controls of this type are unaffected by ambient temperature. *The vapor pressure in the system is always a function of bulb temperature.*

Universal service. For control of temperatures *both* below *and* above the ambient temperature at the bellows, universal systems can be designed that draw on the principles of operation of both the low and the high temperature types just described. The bellows cup, capillary and bulb assembly is charged with a definite, precisely measured volume of the thermal liquid. When the capillary and bellows cup are *completely filled* with the thermal liquid, there must still be enough liquid left in the bulb to generate the necessary vapor pressure.

When the bellows and capillary temperatures go above the operating temperatures at the bulb, the liquid in the bellows and capillary vaporizes, expands into the bulb and condenses. The bellows cup is thus filled with a superheated gas at the same pressure as the vapor pressure generated by the volatile liquid in the bulb. A transition point is reached when the temperature of the bellows and capillary just equals that of the bulb. As the temperature of the bellows and capillary drops *below* that of the bulb, the liquid in the bulb rapidly vaporizes and condenses in the bellows and capillary until they are completely filled. Bulb design provides for some liquid to remain in the bulb. Further temperature increases bring about an increase in vapor pressure which is transmitted hydraulically through the capillary to the bellows cup.

Under any of the above conditions the temperature at the bulb always controls the operation of the system. The universal type control satisfies requirements that can be filled by neither the low-temperature nor high-temperature vapor-pressure types alone.

Dual Fill - Universal service can be obtained by a "dual fill" system. The unit is filled with controlled amounts of two insoluble liquids. Temperature changes are sensed by one liquid and the resulting vapor pressure changes are transmitted hydraulically through the second liquid to the bellows cup. This type of unit can be designed to have the "knock off" characteristics of the limited-fill unit (see Fig. 3).

"Fail-Safe" Design. If a liquid is chosen with a boiling point *above* the control point, the system operates under vacuum up through the control point. Vacuum should usually be limited to about 15 inches of mercury. Vacuum operation provides a "fail safe" feature in such applications as automobile thermostats. In the event that leakage occurs in the bellows or elsewhere in a closed system, the thermostat locks "open" and coolant continues to flow through the system. When controlling a heating medium, the control locks "closed" to shut off the source of the supply of heat.

Thrust. In vapor pressure assemblies, the thrust of the bellows at any temperature is definitely fixed by the vapor pressure of the filling medium and cannot be changed. Similarly, thrust differential between any two temperatures is fixed by the filling medium. Therefore, in the mechanical design of switch or valve mechanisms, friction should be minimized and maintained at a constant value.

Adjustment is commonly achieved by means of a spring and adjusting screw arrangement. The spring can control the operating temperature, the operating differential and the range over which the control temperature can be adjusted. The adjusting spring mechanism must be interrelated with the bellows cup assembly to achieve the desired operating characteristics.

Barometric compensation. For systems requiring extreme accuracy, it is sometimes desirable to compensate for barometric changes. Such correction is provided simply and accurately by a Clifford differential pressure unit (see Fig. 6). The vapor pressure is transmitted to the outside surface of the large bellows. The other side of the bellows is evacuated. The barometric changes then act on the areas of the smaller bellows, producing a null effect.

Clifford Manufacturing Company will consult with you regarding a thermostatic assembly that will meet your requirements. If you have an immediate problem, send a sketch showing controlling factors of your application and we will recommend a suitable control.

Clifford Manufacturing Company, 139 Grove Street, Waltham 54, Mass., *Division of Standard Thomson Corporation.*

Sales offices in New York, Detroit, Chicago, Los Angeles, Waltham, Mass.

7-5-14

Figure 5. Temperature regulators for water heating or cooling tanks, steam cookers, acid baths, glue heaters, bottle washers, tempering baths and other heating specialties used Clifford vapor pressure bellows assemblies as actuating elements.

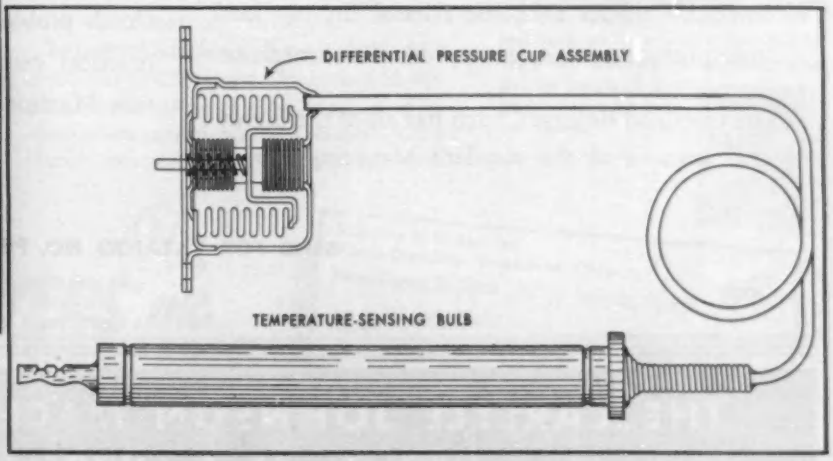


Figure 6. Vapor pressure bellows assembly with automatic barometric compensation.

MAXITORQ
Overload Release
CLUTCH

protects against conveyor overload

FOR THE LAMSON CORPORATION

This prominent Syracuse, N. Y., manufacturer of materials handling equipment has selected the Maxitorq Overload Release Clutch for power transmission on its drive unit for the Lamson overhead conveyor. On installations which handle heavy loads the cam design feature automatically causes instant disengagement of the clutch when the overload is substantially greater than the normal driving load . . . thus preventing damage to product and machine.

The Overload Release Clutch has all of the highly favored features of the standard Maxitorq floating disc clutch . . . Separator springs that keep discs "floating" in neutral . . . no drag, no abrasion and, consequently, no heating in neutral. Assembly, adjustment and take-apart are made without use of tools. Engagement is easily controlled, with light pressure. Disengagement is instant and complete.

There are six capacities, ¼ to 5 h.p. at 100 r.p.m. Maximum working torque from 13 to 263 ft. lbs. There are so many varied applications of this Overload Release Clutch that we suggest submitting your clutch problems to our engineering department for practical recommendations. In other words, "let's talk Maxitorq."

SEND FOR CATALOG NO. PE-5

6C254

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

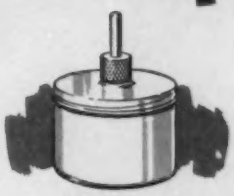
You name it-MOYNO® pumps it!

Foods

Potato salad, chow mein, peas, cream-style corn, tomatoes, molasses, chocolate.

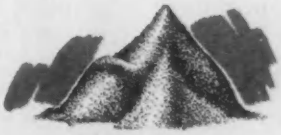
Chemicals

Caustics, acids, dyes, petroleum solvents, soaps, sludges, latex, synthetic resins.



Pastes

Paper coating, starch, seam paste, size, adhesive dope, heavy grease, graphite sludge.



Abrasives

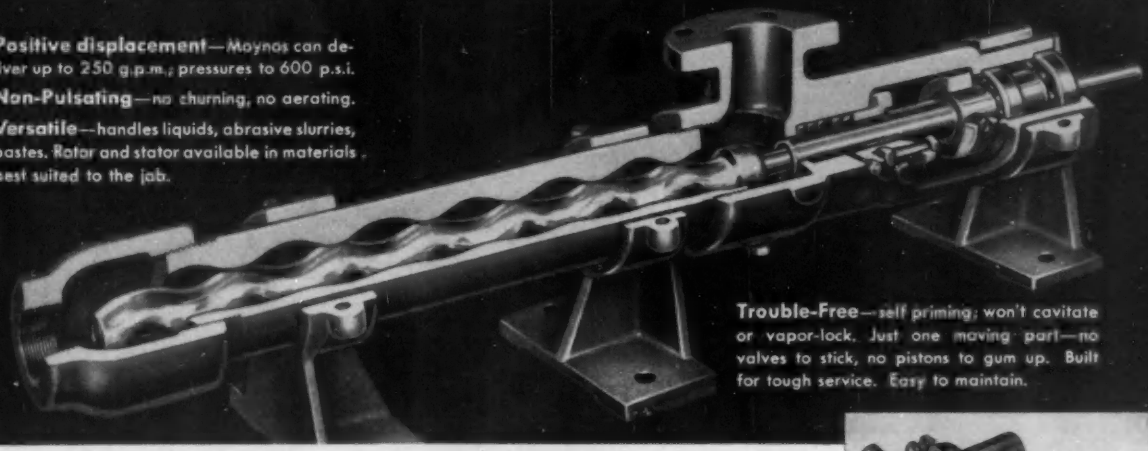
Insulator clay, frit, ground glass and water, porcelain glaze and enamel, cement, plaster.

FEATURES OF THE MOYNO THAT MAY SOLVE YOUR MATERIALS-HANDLING PROBLEM

Positive displacement—Moynos can deliver up to 250 g.p.m.; pressures to 600 p.s.i.

Non-Pulsating—no churning, no aerating.

Versatile—handles liquids, abrasive slurries, pastes. Rotor and stator available in materials best suited to the job.



Trouble-Free—self priming; won't cavitate or vapor-lock. Just one moving part—no valves to stick, no pistons to gum up. Built for tough service. Easy to maintain.

R & M Moynos handle almost anything that can pass through a pipe

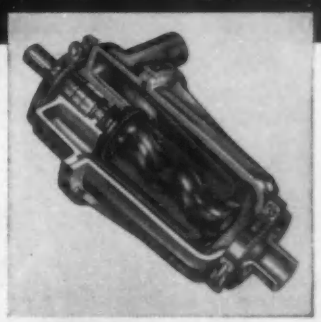
The Moyno is a problem-solving pump. And whether your problem is one of materials, maintenance or flow, there's a better-than-even chance that the Moyno is the pump you're looking for.

Here is a completely different kind of pump that handles almost anything that will push through a pipe, from free-flowing liquids to non-pourable pastes—even materials containing relatively large particles or abrasives.

This is how the Moyno works: a screw-like rotor turning within a double-threaded stator creates cavities which *progress* toward the discharge end of the pump, carrying the material being handled. The result is a smooth, steady flow, free from pulsation and turbulence.

The pumping elements of the Moyno are available in a wide range of materials, depending upon the substances to be pumped. From stainless steels and synthetic rubber to tool steels, bronze, plastics—there is a Moyno that will do the job you want, and do it with remarkable efficiency.

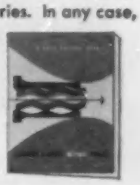
Industrial-type Moynos are available with capacities to 250 g.p.m.; pressures to 600 p.s.i. Small Moynos (see inset), used as original equipment, serve on washers, water pumps, sprayers, and many other products.



FREE...

this informative bulletin

Tell us your pumping problem—let's see how the Moyno can help solve it. If necessary, we'll be glad to run tests for you in our own laboratories. In any case, get the details on the Moyno—mail the coupon below.



R&M®

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

Fractional and Integral HP Motors

Desk, Window, and Household Fans

Hoists and Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

Robbins & Myers, Inc.
Pump Division, Springfield, Ohio (PD)

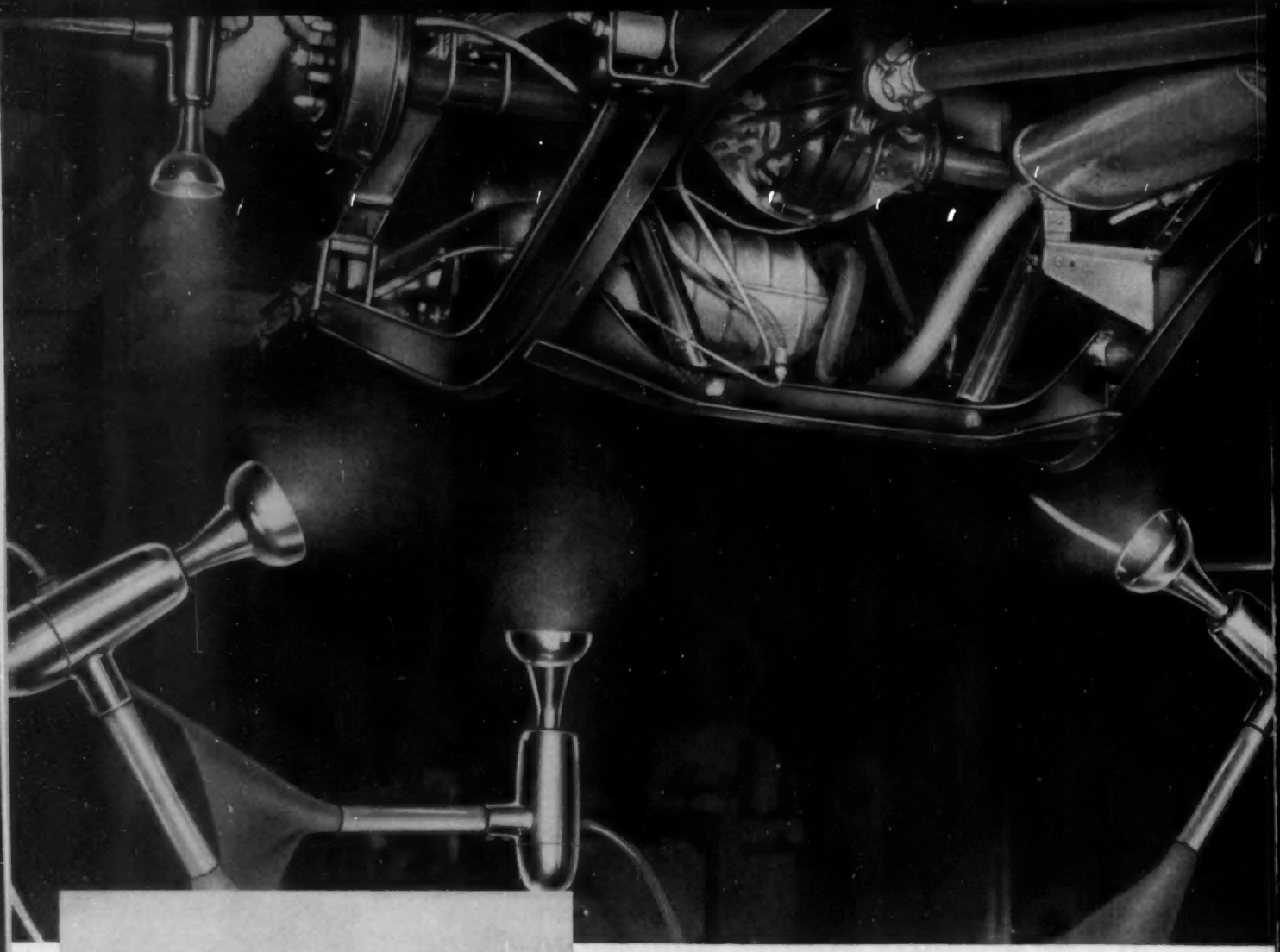
Please send Bulletin 30C on Moyno Pumps

Name _____ Title _____

Company _____

Address _____

City _____ State _____



R&M MOTOR PARTS AT WORK

A prominent passenger car manufacturer gets eleven times more chassis per gallon—reducing paint and production costs substantially—with the efficient, high-quality electrostatic paint spray process of the Ransburg Electro-Coating Corp., Indianapolis, Ind. Robbins & Myers polyphase motor parts are utilized to atomize the paint spray in an electrostatic field. The spray is attracted to the products, which are grounded through the hanger, producing a high degree of uniformity of finish.

◀ Rugged rotor and stator for a polyphase portable tool. The rotor consists of squirrel cage, embedded in laminated core with bars and end rings of copper, brazed or welded together. The stator has a high-grade silicon steel core with top-quality rag paper used to insulate the coil from the core. The finished winding is taped and thoroughly impregnated with high-grade synthetic resin base varnish to assure trouble-free operation with minimum danger of short circuits and grounds.

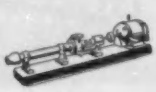
ROBBINS & MYERS, INC.

MOTOR DIVISION: SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

Household Fans

Electric & Hand Hoists & Cranes



Moyno Pumps

Propellair Industrial Ventilating Equipment

R & M SPECIALISTS INTEGRATE MOTOR AND MACHINE DESIGNS... TO ASSURE HIGHEST PERFORMANCE

Many factors must be considered in designing a new motor-operated product that will perform its intended functions accurately, economically, and with a low maintenance and failure rate. Much depends on the proper correlation and integration of motor and machine designs. A special knowledge of motor application can be valuable to you. Robbins & Myers motor design specialists can help you solve these problems, to whatever extent you desire.

The exact motor for your machine is worked out quickly and accurately, with systematic methods of designing motors. This might include, for example, the use of R & M's unique "Electrical Slide Rule." Electrical equivalents can be set up on the slide rule to simulate the conditions under which the motor must operate in your product. By this method we are able to investigate hundreds of different design possibilities, assuring the best motor for the job.

In some cases the answers point to a standard motor. And here, R & M offers a wide variety of types and sizes of complete motors or matched motor parts.

In other cases special motors are indicated. R & M is equipped to do a fast, thorough, economical job of custom-designing a motor that's exactly right for your product.

Don't settle for an "off-the-shelf" compromise. Standard or custom-designed, R & M will get you the right answer quickly —with no obligation!

R & M MOTORS AND MOTOR PARTS POWER MANY TYPES OF EQUIPMENT, SUCH AS . . .

Portable Saws	Routers	Nut Setters	Hedge Trimmers
Drills	Screw Drivers	Hammers	Lawn Mowers
Nibblers	Pumps	Polishers	Oil Burners
Lock Mortisers	Compressors	Planers	Surgical Instruments
Valve Grinders	Hones	Portable Grinders	Grease Guns
Vacuum Cleaners	Business Machines	Sirens	Vibrators
Fans	Cast Cutters	Advertising Devices	Die Sinkers
Sanders	Food Mixers	Ventilating Equipment	Waxers

R&M MAKES BOTH!
Fractional-horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral-horsepower motors; famous R&M "All-Weather"* with sealed bearings. Up to 125 h.p.

**"All-Weather" is an R & M trademark*

This coupon will bring you prompt information. PD

Robbins & Myers, Inc., Motor Division, Springfield 99, Ohio

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ R & M "All-Weather" Motors —up to 125 h.p.
- ☐ Please have a Motor Specialist call

Product we manufacture: _____

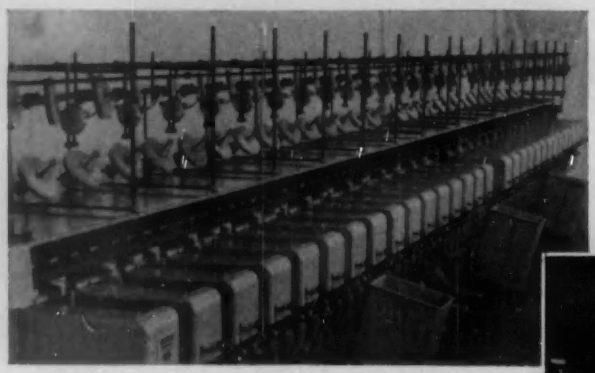
Name _____

Title _____

Company _____

Street _____

City & State _____



Perfect Partner for Metal

"U. S. Royalite saved us 66% in costs and gave us 7 outstanding advantages."

L. M. Sawtell
Foster Machine Co.
Westfield, Mass.

The giant machine shown above is a Foster Muschamp Model 66 bobbin winder. The empty bobbins (or pirns) which are fed along the top of the machine, drop off a belt into receivers known as pirn magazines. All day long these pirn magazines take a series of impacts at the maximum rate of one a minute. They must be TOUGH and DURABLE!

Duplicon, Inc., Westboro, Mass., specialists in combining plastics with metal, engineered, designed and produced this pirn magazine for Foster Machine Company by riveting easily formed, tough, versatile Royalite "2,000" to steel. In addition to the substantial material savings over all-steel construction, seven other advantages were quickly apparent:

- Lighter in weight.
- Noiseless during operation.
- Will not rust, even under high humidity.
- No painting necessary.
- Neater in appearance.
- Less expensive tooling.
- Greater flexibility.

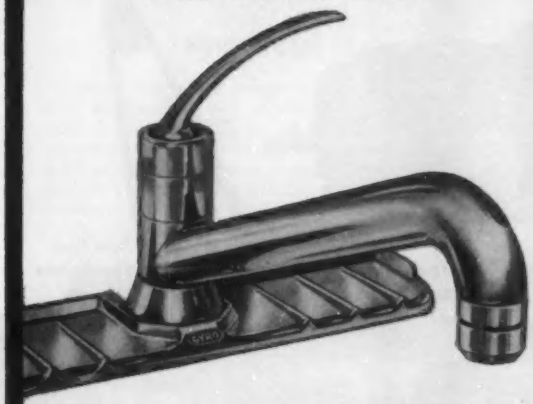
U. S. Royalite "2,000" is the perfect running mate for all metals. It can be formed on low-cost tools, sawed, bent, punched or drilled, then bolted or riveted to metal. Learn all about this fabulous fabricating material by writing to:

US RUBBER

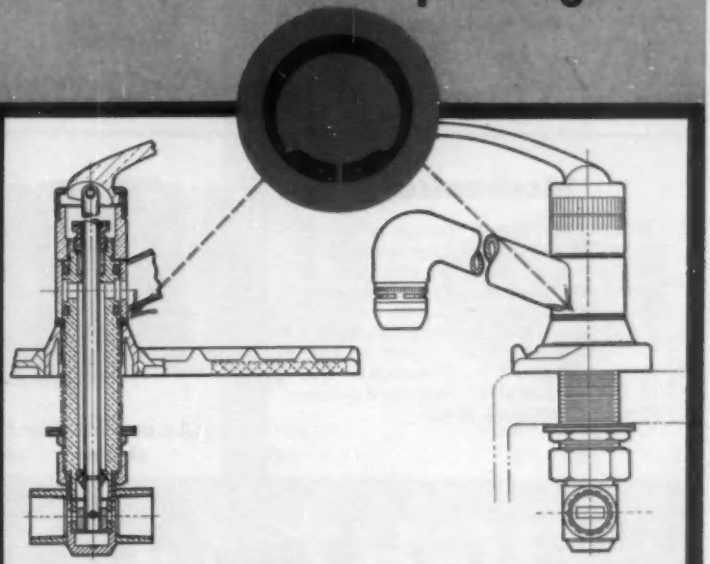
UNITED STATES RUBBER COMPANY
2638 NORTH PULASKI ROAD, CHICAGO 39, ILLINOIS

Waldes Truarc ring reduces valve body from 1 5/16" to 1 1/16", eliminates chrome plating

GYRO MIXING FAUCET



Single-handle kitchen mixing faucet controls hot and cold water, as well as volume. Radical design has no seals or spindles to replace. One Waldes Truarc retaining ring allows complete assembly and disassembly from either top or bottom of unit.



Aluminum Truarc Ring (external inverted Series 5108) acts as bearing retainer, insures precise alignment of spout and escutcheon, gives uniform shoulder with machining. Truarc ring provides shoulder that would otherwise require machining valve body to 1 5/16" against 1 1/16" used. Also eliminates expensive chrome plating of valve body.

Gyro Brass Manufacturing Corporation of Westbury, L. I., N. Y., uses a single Waldes Truarc retaining ring (Series 5108) both as a positioner and retainer on their Gyro Mixing Faucet. Aluminum Truarc ring not only eliminates expensive machining, but also does away with a chrome plating process that would be necessary if the shoulder were made of the solid material of the body.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

More than 5,000 stock sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name.....
Title.....
Company.....
Business Address.....
City.....*Zone*.....*State*.....

PN057

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

Mechanical

Where moderate speed range is required and where machine may be stopped to make speed changes. Horsepower range—1½ to 300. Speed adjustment range—9 to 28 percent. Two *Vari-Pitch* sheaves used together double range of adjustment.

Combination starter

Squirrel-cage motor

Vari-Pitch stationary control drive

Mechanical

Where infrequent change of speed in low horsepower drives is required and machine may be stopped for speed adjustment. Especially suitable for fan drives, stokers, small pumps and tools. Horsepower range—fractional to 4 hp. Speed adjustment range—18 to 50 percent. Use of two adjustable sheaves doubles speed adjustment range.

Across-the-line starter

Squirrel-cage motor

Texrope adjustable drive

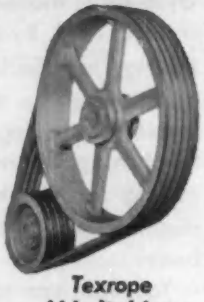
EIGHT WAYS TO GET VARIABLE SPEED

Electrical

Where stepped speed control is satisfactory. Available with stepless control in larger sizes by using liquid rheostat. Speed is varied by means of control on secondary windings of motor. Horsepower range—5 hp and up. Speed adjustment range—50 percent of synchronous speed to full load speed.

Wound-rotor motor control

Wound-rotor motor

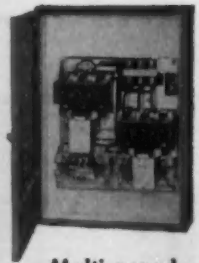


Texrope V-belt drive

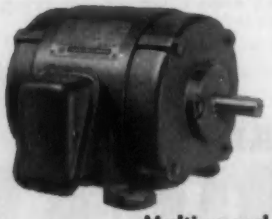
Electrical

Where a few definite speeds are required. Up to four speeds available from one motor. Motor is built on standard squirrel-cage frame with special windings and control. Furnished for variable torque, constant torque and constant horsepower. Horsepower range—½ hp up.

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.



Multi-speed motor starter



Multi-speed squirrel-cage motor

Texrope V-belt drive

Write for Engineering Literature

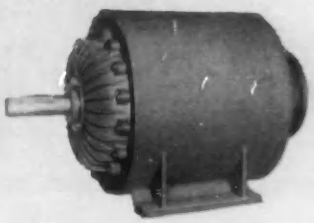
A-C ALLIS-CHALMERS

ALLIS-

Mechanical

Where speed must be changed while machine is in motion. Particularly good for machines requiring fine adjustment while operating. Double range of adjustment may be obtained by using two *Vari-Pitch* sheaves. Horsepower range—1½ to 600. Speed adjustment range—9 to 28 percent with one *Vari-Pitch* sheave.

Reduced voltage starter



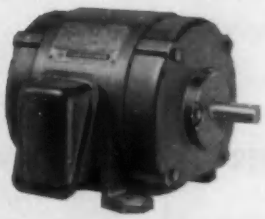
Squirrel-cage motor

Vari-Pitch motion control drive

Mechanical

Where very wide range speed control is required or where enclosed unit is desired. May be manually or remotely controlled. Motor may be mounted on speed changer housing for compact installation. Horsepower range—1½ to 75. Speed adjustment range—3¾ to 1.

Across-the-line starter



Squirrel-cage motor

Vari-Pitch speed changer

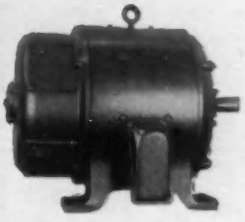
ALLIS-CHALMERS
Drives for Designers

COMPLETE DRIVES from One Reliable Source

Electrical

Where great versatility is required. Speed may be varied by various types of control, either stepped or stepless. For both constant and variable torque loads. Horsepower range—½ hp up. Speed adjustment range—zero to maximum speed. Maximum speed in smaller sizes, 3500 rpm.

Direct current control



Direct current motor

Texrope V-belt drive

Combination

Where extremely wide range is required, a combination drive adds the speed control range of the motor to that of the *Vari-Pitch* drive. Hundreds of combinations of any of the above units can be worked out to fit the requirements of a particular design.

Wound-rotor motor control

Wound-rotor motor

Vari-Pitch motion control drive

A4523

CHALMERS

Milwaukee 1, Wisconsin

UNICHROME

News about

COATINGS for METALS

Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

Protective plastisols gain new versatility

Make shorter work of finishing problems

When up against a finishing problem, many engineers and designers like to get the opinions of a finishing specialist. They prefer to consult a company that knows many types of finishes.

Because United Chromium has developed plating processes, specialized organic protective coatings, and a wide line of chromate finishes, it can be a real help in suggesting the best type of finish to meet service, appearance and cost requirements.

ELECTRODEPOSITED COATINGS

Unichrome Copper, Nickel and SRHS Chromium comprise the first matched set of plating processes. This means one source, one responsibility for proper operation which in turn means the finest finish of its kind plus smoother running production.

UNIQUE ORGANIC COATINGS

Developed to meet unusual requirements, Unichrome lacquers, synthetics, enamels are now available in a broad range to block corrosion, add long life to the eye appeal of a product.

CONVERSION COATINGS

Chromate treating strengthens corrosion resistance of zinc die castings and plate. It offers an easy, economical way to finish. With Unichrome Dips, high quality also is obtainable — quality measured in durability and appearance.

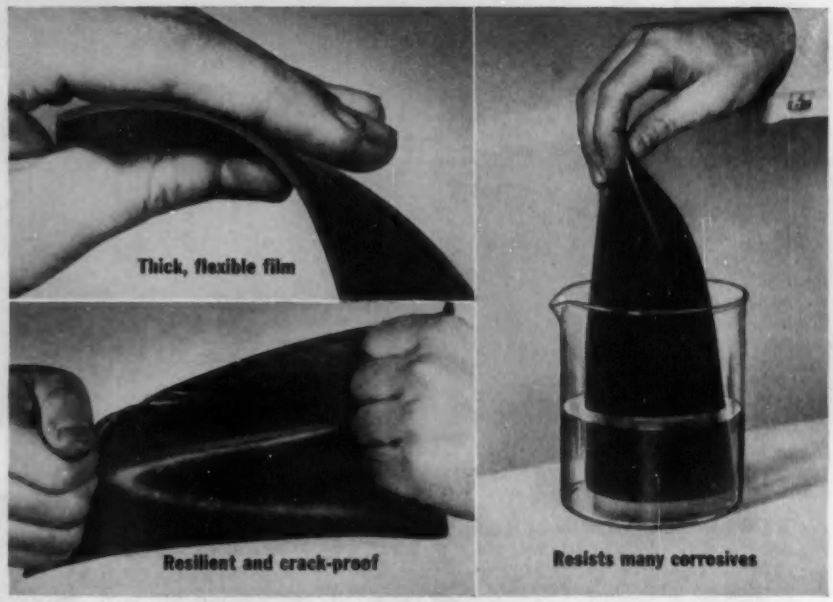
* * *

More information is as close as the United Chromium office nearest you.

UNITED CHROMIUM, INCORPORATED

100 East 42nd Street, New York 17, N. Y.
Waterbury 20, Conn. • Detroit 20, Mich.
Chicago 4, Ill. • Los Angeles 13, Calif.
In Canada:
United Chromium Limited, Toronto 1, Ont.

Advantages of Unichrome heavy-duty vinyl compounds now obtainable even with sprayed coatings



PLASTISOL compounds are liquids, which when heat cured, build up vinyl plastic finishes that look and feel like rubber, but there the resemblance ends. Plastisols offer truly remarkable chemical resistance, which is further fortified by the tough, substantial film thickness achieved in one coat.

SEAMLESS, THICK-FILM PROTECTION

Any metal surface that can be uniformly baked can now be strongly protected against severe and corrosive service conditions by Unichrome 4000 Series Plastisol Compounds—or the new Coating 5300. The first practical *sprayable* plastisol, Unichrome Coating 5300 fills the need for a plastisol suitable for application to products too large to be dip-coated.

A 20 mils thick, non-sagging coat can be applied even to cold vertical surfaces in just one application with Coating 5300. That's 5 to 20 times thicker than ordinary coatings. Unichrome Series 4000 Plastisols, which are applied by almost any other conventional method, produce coatings up to 3/16" thick. Plastisols can do jobs for which sheet materials have been used.

CHEMICAL RESISTANCE OF VINYLS

Unichrome Plastisols offer seam-free and pore-free protection against acids, alkalies, water, salt solutions and many other corrosive agents. They bake into an abrasion-resistant resilient coating that doesn't crack, chip or tear. With such protection, ordinary metals can often be used in place of costly alloys.

The chemical resistance, physical toughness, electrical insulating properties, and speed of curing of Unichrome Plastisols combine to offer engineers a new tool for protection and finishing. Send for Bulletin VP-1.

Ideal for: freezers, washers, dryers, heaters, stoves, percolators, rotisseries, broilers, ovens, deep fat fryers, waffle irons, ironers, dish washers, vacuum cleaners, instruments.

NEW

snap-in

NEON INDICATOR LIGHTS

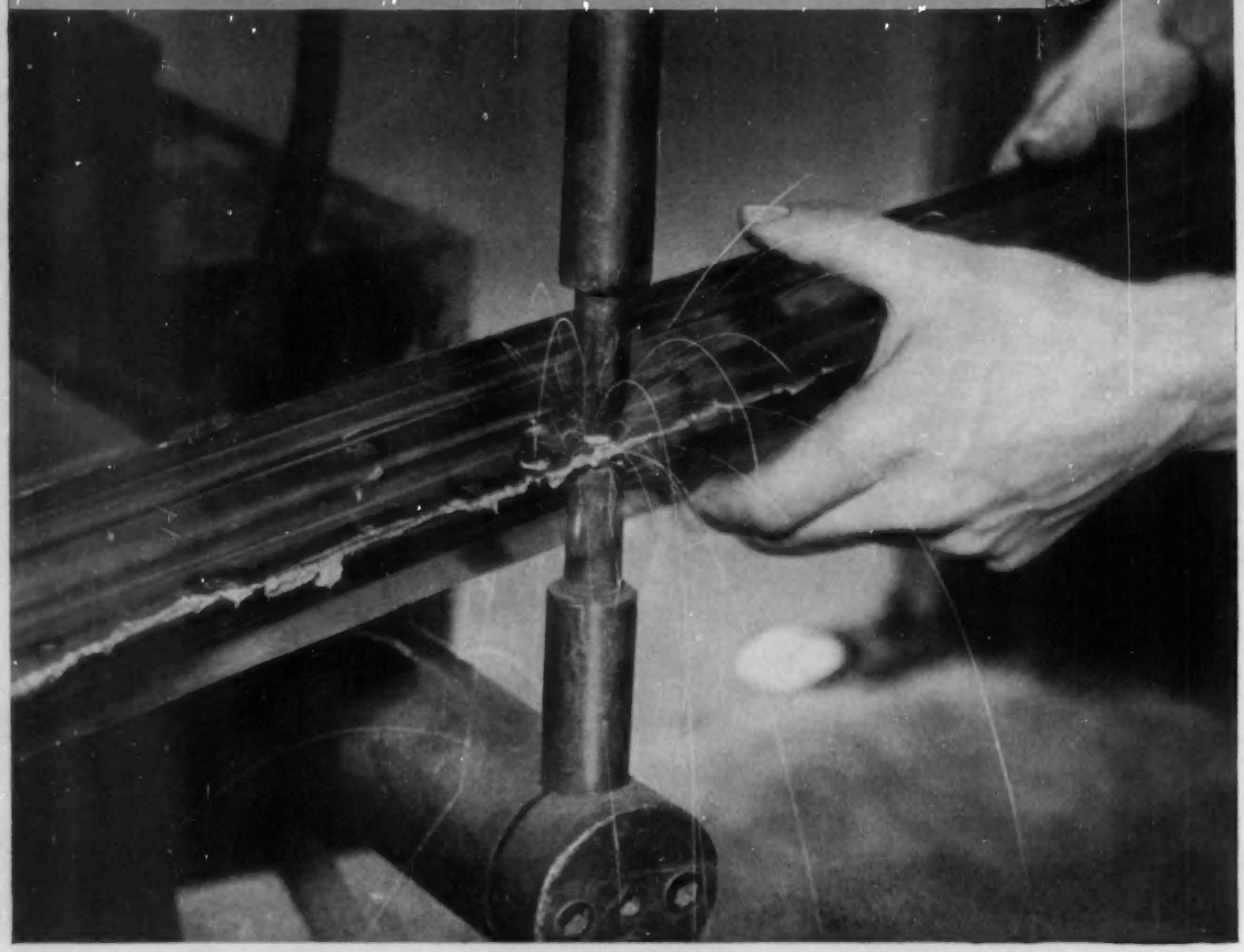
- LOWEST COST COMPLETE ASSEMBLY ON THE MARKET
- CAN BE SUPPLIED WITH WIRE LEADS OR QUICK DISCONNECT
- NO TRANSFORMERS, NO SERIES HOOK-UPS NECESSARY
- NO GLARE, ONLY A SOFT, STEADY GLOW
- SMALLEST COMPLETE ASSEMBLY AVAILABLE
- SPECIAL STYLING TO YOUR SPECS. ON VOLUME ORDERS
- WIDE RANGE OF LENS COLORS AND CONFIGURATIONS
- LONG, TROUBLE-FREE OPERATING LIFE

Write, wire or phone your nearest Ucinite or United-Carr representative for further details.

THE UCINITE COMPANY

Division of United-Carr Fastener Corporation
Newtonville 60, Mass.

See what adhesives are doing today!



Sealing a spot-welded "sandwich"

3M ADHESIVES

If any operation in your plant requires a welded seam to be weather- and water-tight, take another look at the picture above. The filling you see in that all-steel "sandwich" is a unique 3M product called EC-1168—a weld-through sealer.

Under the high flash "fire" of the spot-welding operation, EC-1168 shows not a trace of splatter or burning. It squeezes away from the immediate weld area, yet fills in tightly all around the weld to maintain a permanent, *flexible* seal. With EC-1168, you can seal far more effectively because you utilize the full width of the seam, rather than the usual slender bead at the lap edge.

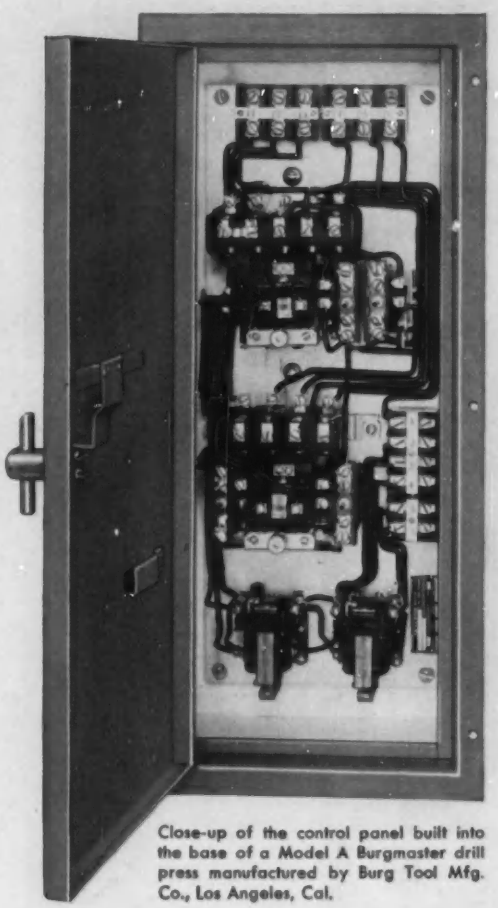
See what adhesives can do for you...

Automobile and truck manufacturers—heating and air-conditioning companies, too—have found EC-1168 to be one of many 3M products valuable to them in doing a better job. If *you* have a design or production problem, let 3M put its research and resources into solving it. Call in your nearest 3M Field Engineer. Or write 3M, Dept. 45, 417 Piquette, Detroit 2, Mich.

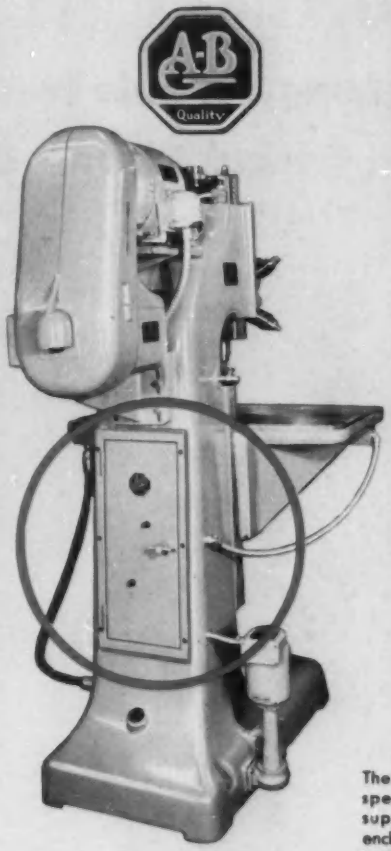
ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

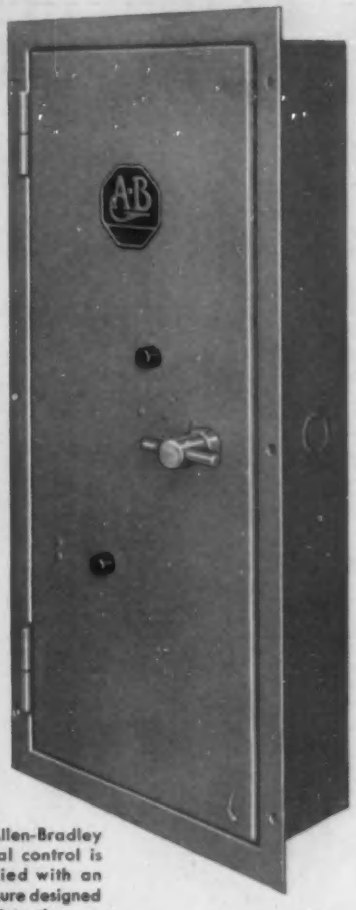
417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N. Y. 16, N. Y. • CANADA: P. O. BOX 757, LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



Close-up of the control panel built into the base of a Model A Burgmaster drill press manufactured by Burg Tool Mfg. Co., Los Angeles, Cal.



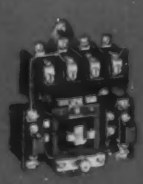


The Allen-Bradley special control is supplied with an enclosure designed to fit into the machine frame.

The ALLEN-BRADLEY "QUALITY" TRADEMARK

IS A BIG SALES ASSET TO YOUR MOTORIZED MACHINES

QUALITY COMPONENTS for A-B Control Panels



Size 1 Automatic Starter

Size 1 Manual Starter

Bulletin 849 Pneumatic Timer

Bulletin 700 Universal 4-pole Relay

Wherever possible, control apparatus ought to be built into the machine frame. The modern, streamlined appearance will appeal to your customers.

See how neatly the Burg Tool Mfg. Co. has integrated the compact Allen-Bradley control panel into their machine pedestal. The panel is assembled from Allen-Bradley standard, catalog listed items known to be good for millions of trouble free operations.

Let us help you add a real sales asset to your machines!

Allen-Bradley Co.
1316 S. Second St.
Milwaukee 4, Wis.

In Canada—
Allen-Bradley Canada Ltd.
Galt, Ont.

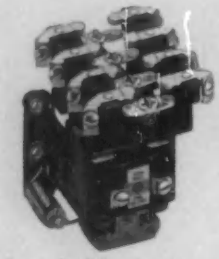
7-55-R

ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

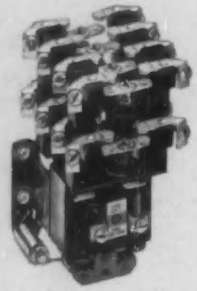
QUALITY RELAYS

for Long, Trouble Free Service in Critical Control Circuits

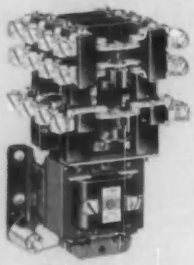
Type C-200 A-C 2-pole relay



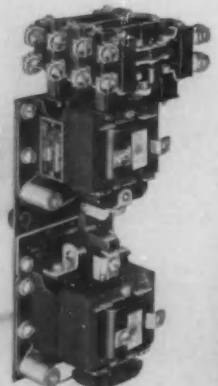
Type B-400 normally open 4-pole relay



Type B-800 normally open 8-pole relay



Type BX-840 universal 8-pole relay



Type BXL-440 universal relay with latch

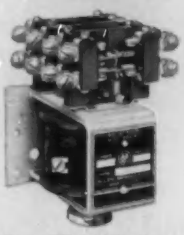
Type BX-44 Universal 4-pole relay in NEMA Type 1 general purpose enclosure. To change from N.O. to N.C. contacts, or vice versa, just change terminal connections. Max rating—10 amperes.

Here is a line of small relays that is ruggedly built for tough industrial service. The simple solenoid design... with ONLY ONE MOVING PART... guarantees millions of failure free switching operations. The double break, silver alloy contacts need no cleaning, filing, or other maintenance. For complete Allen-Bradley relay data, please write for Bulletin 700.

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.

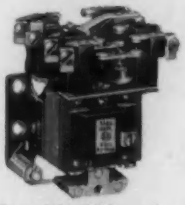
In Canada—
Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
BULLETIN 700 RELAYS
QUALITY

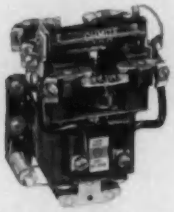


Type EX-440 D-C universal relay

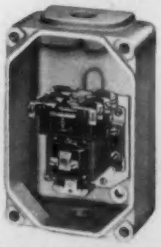
Type BX-220 universal 2-pole relay



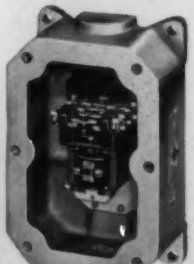
Type BM-200 mechanically held relay



Type BA-20 2-pole thermostat relay



Relay in watertight enclosure



Relay in explosion-proof enclosure

7-55-MR

Industrial Monkey Gets a "Lift" from SHELBY SEAMLESS TUBING

The versatile Industrial Monkey* is ideal for all types of high work operations including tree-trimming, line work, street light servicing, painting, shipyard work, airplane servicing, and fire fighting.

The basic Industrial Monkey unit consists of a hydraulically-operated telescoping boom with a self-leveling work platform. The boom, mounted on a base, swings in a 270 degree arc and operates from the horizontal to vertical at a working height of 50 feet. All movements are electrically controlled, either from the work platform or from dual controls in the truck upon which the unit is mounted.

The agile swinging boom is comprised of an inner and outer member —both of Shelby Seamless Mechanical Tubing. Shelby Seamless is just the ticket for applications like this, for it offers the high strength, uniformity, dimensional accuracy, and dependability that only *seamless* can give. It is available in a complete range of diameters, wall thicknesses, and steel analyses to meet exacting requirements.

If you feel you'd like further information on applying Shelby Seamless Mechanical Tubing to your product, our engineers are at your disposal. Contact them at any time.

*Manufacturer's name on request.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS Shelby Seamless Mechanical Tubing

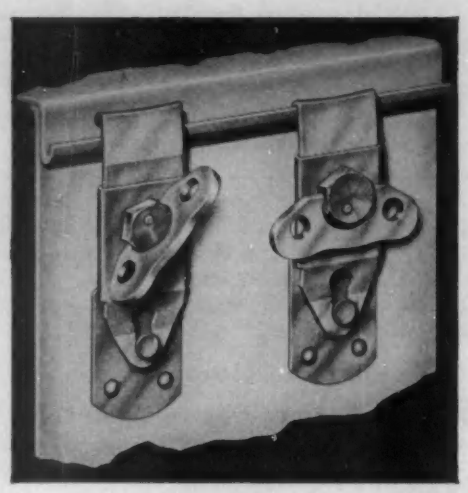
SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

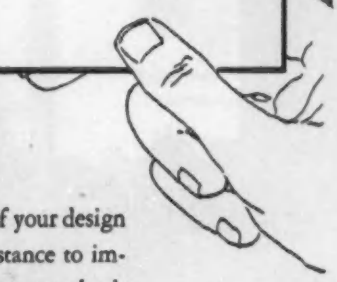
UNITED STATES STEEL

Have you a similar fastening problem?

File: Simmons LINK-LOCK



When the armed forces needed a positive, high-strength fastening device for instrument housings, transit cases, and storage boxes, Simmons developed LINK-LOCK. This *brand-new* device doesn't use springs, yet works with fingertip pressure through a unique mechanical arrangement: the vertical sliding latch is moved in and out of locking position by a disc rotated with a wing nut. The fastener is immune to low temperatures, is easy to operate even with arctic mittens, furnishes up to 450-lb. pull-down pressure. Open or closed, it lies flat against the side of the case it fastens.

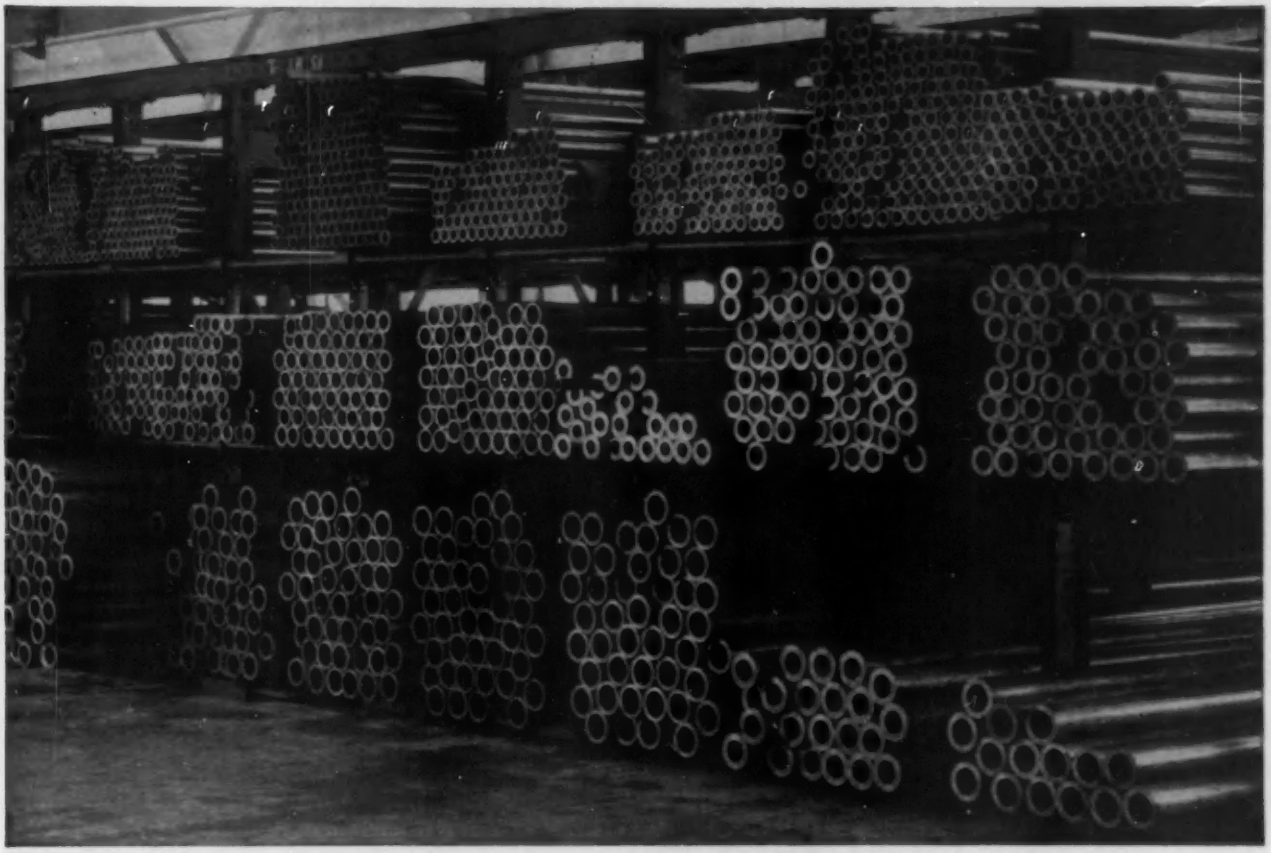


LINK-LOCK may be the answer to your fastening problem. If your design involves heavy fastening pressures, watertight sealing, high strength, resistance to impact, ask about LINK-LOCK. Simmons can furnish it with special engagement-latch details, or for operation by bolt or screwhead instead of wing nut. Write for LINK-LOCK DATA SHEET today. It gives complete details and dimensions. A Simmons engineer will be glad to work with you on your fastening problems.

SIMMONS FASTENER CORPORATION, 1751 No. Broadway, Albany 1, New York

Simmons QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

JUST OUT! NEW 36-PAGE CATALOG WITH APPLICATIONS SEND FOR IT!



What size 52100 steel tubing do you need? We'll ship tomorrow!

WE carry 101 different sizes of Timken® 52100 steel tubing in warehouse stock—from 1″ O.D. to 10½″. If you order today, we'll ship tomorrow!

52100 is a high-carbon chromium steel that will do most of your hollow parts jobs. In moderate sections it will through-harden and it has been used in place of more expensive steels. You can heat treat it to file hardness and then temper back to any desired point.

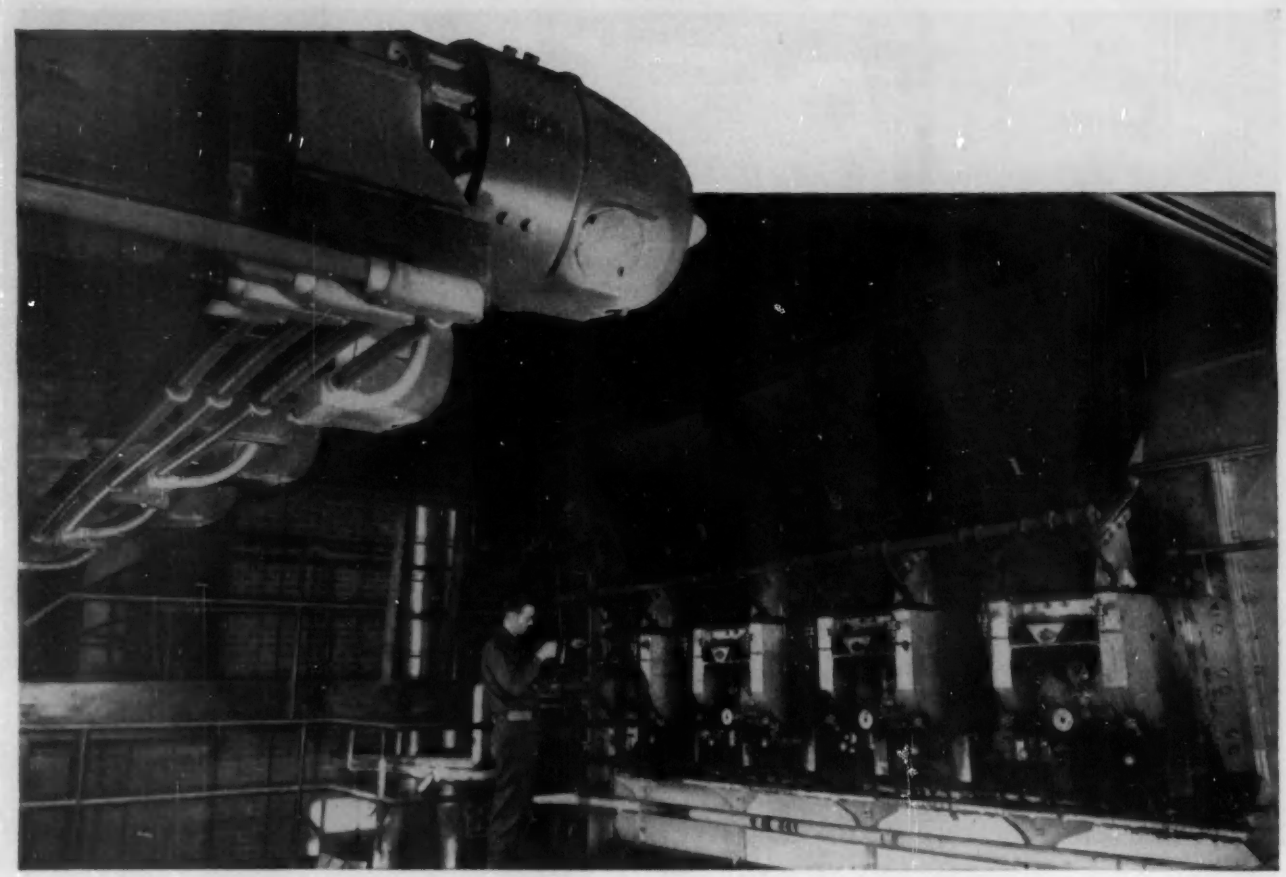
Timken 52100 steel is ideal for hollow-parts jobs like these: aircraft parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts and precision instrument parts.

The Timken Company is America's pioneer producer of 52100 tubing. We have a background of experience in making it that can't be equalled. We've developed rigid quality control procedures that check every step of the operation. Result: uniform high quality from tube to tube, heat to heat.

Write, wire or phone us now for immediate delivery of your less-than-mill-quantity orders of 52100. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



Drive mounting problems erased with Westinghouse *Life-Line** Gearmotors

Putting the best drive in the minimum space is a problem constantly facing design engineers. In answer to this problem, Westinghouse Life-Line Gearmotors provide unit compactness, rugged construction and job-proved efficiency.

Westinghouse Life-Line Gearmotors have both motor and gears designed as an integral unit. As a result, there's a major saving in space because all belts, chains and pulleys can be eliminated. This means no alignment problems. Since integral design lessens the number of wearing parts, over-all maintenance is cut to a minimum.

With split-case gearmotors, there's no need to allow large work areas for removal or dismantling—all servicing can be done with the gearmotor "on the job". Split-case construction permits the gear cover to be removed in minutes and makes all working parts readily accessible. Any servicing, therefore, becomes a simple, speedy operation.

Taper-hardened gear teeth, thorough lubrication and industry-tested Life-Line Motors are but a few of the features which assure long, dependable performance from Westinghouse Gearmotors.

Your local Westinghouse Representative will gladly furnish you with additional information. Call him at any time or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. *Trade-Mark J-07322

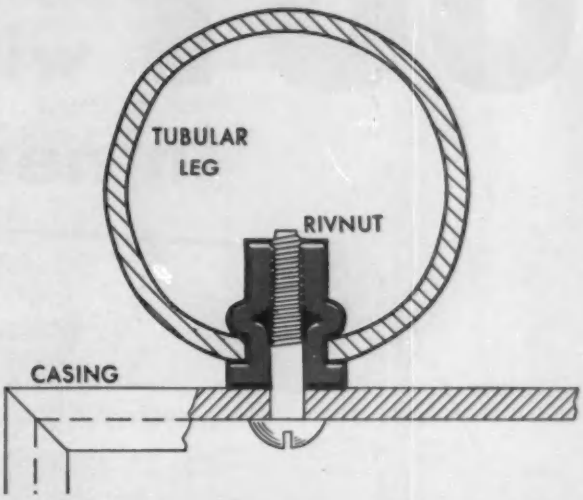
YOU CAN BE SURE...IF IT'S Westinghouse

B. F. Goodrich RIVNUTS cut costs by reducing assembly time

B. F. GOODRICH RIVNUTS boost hourly output because they provide a firm, accurate nut plate in one, quick operation. Nuts and bolts, welding, clinching, tapping are eliminated.

The diagram at right shows why the Big Boy Mfg. Company switched from nuts and bolts to Rivnuts for fastening tubular legs onto its barbecue. One person installs a Rivnut in a couple of seconds. Threads are clean for screw attachment. There are no boltheads on the outside to detract from the barbecue's clean lines. Assembly is faster. Manhours are saved, too, in knockdown for shipping.

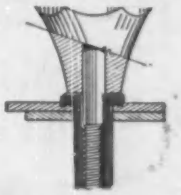
If you're looking for a fastener that can improve your product and cut production time, get more information and engineering help by calling in a B. F. Goodrich Rivnut engineer. The B. F. Goodrich Company, Department PE-55, Akron, Ohio.



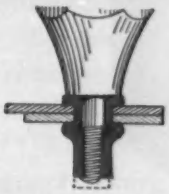
B. F. Goodrich Rivnuts cut costs in other applications on this Big Boy Barbecue. After legs are fastened, worker installs Rivnut that does 3 jobs —serving as bearing, locating and locking device on movable fire bed.

Rivnuts provide at least 6 clean threads in one simple operation!

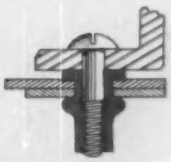
1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.



3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

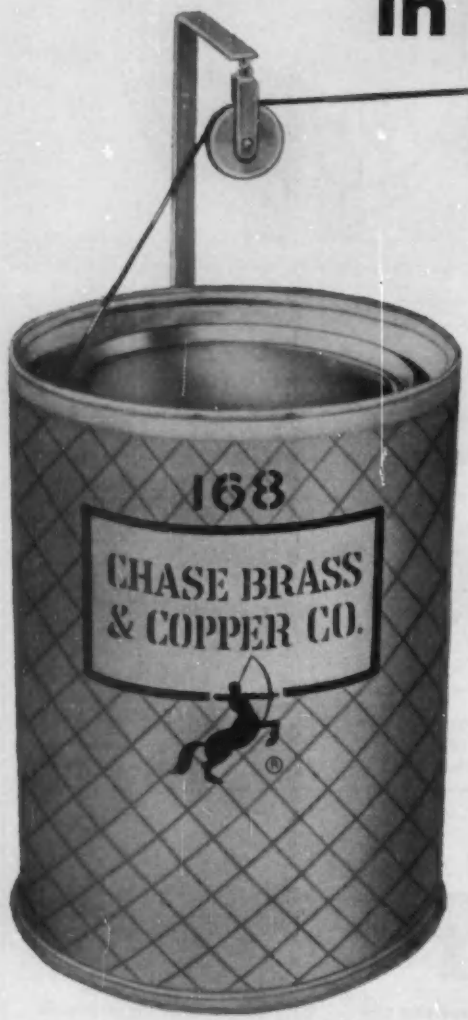
Demonstrates with motion how you can use Rivnuts to fasten TO and fasten WITH. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Department PE-55, Akron, Ohio.

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

CUT Wire forming costs with CHASE® WIRE in new *Payoffpaks*!

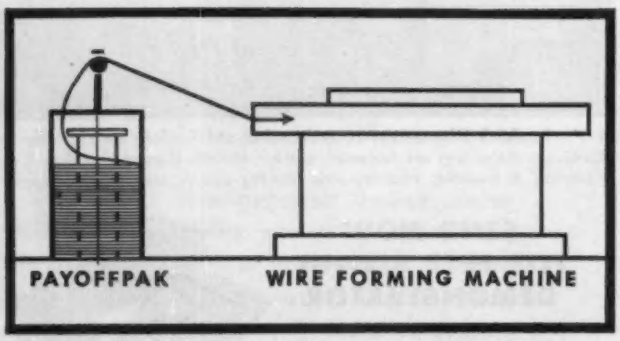


Now, in this compact, easy-to-handle PAYOFFPAK you can get a continuous length of Chase copper alloy wire weighing 400 to 500 pounds!

This new Payoffpak puts an end to frequent set-up of wire-forming machines . . . means *more* continuous, economical operation, *less* costly down time!

You'll like the easy way this Payoffpak handles, the space-saving way it stores . . . and the way it protects the shining surface of Chase copper alloy wire from rough handling in transit and storage.

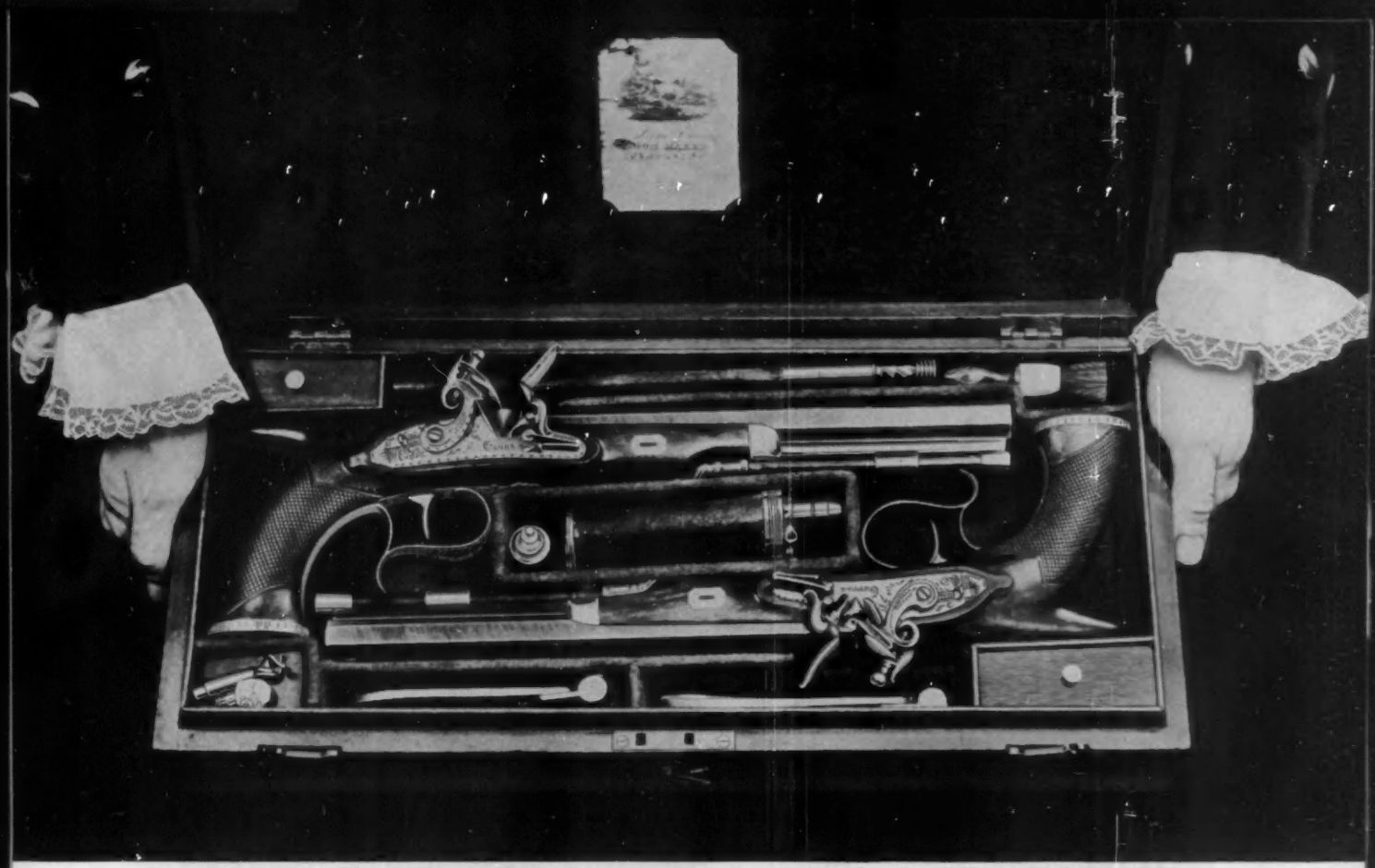
Ask your Chase Wholesaler or nearest Chase Warehouse about the new Payoffpak the next time you order copper alloy wire.



Chase®
BRASS & COPPER CO.
WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Detroit	Los Angeles	New York	St. Louis
Atlanta	Cincinnati	Grand Rapids†	Milwaukee	Philadelphia	San Francisco
Baltimore	Cleveland	Houston	Minneapolis	Pittsburgh	Seattle
Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)



From the collection of Paul J. Westergard, New Jersey Arms Collectors Club. Maker: Samuel Evans, Cambridge, England, 1800-1820. Prints of this illustration suitable for 11 by 14 frame available on request on company letterhead.

Choose your weapon.....

TO COMBAT FRICTION

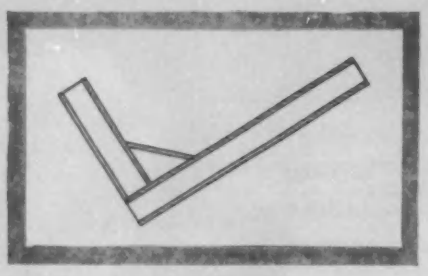
Armed with the proper weapon you'll always be the winner in the unending duel of friction versus lubrication. There's never a misfire when you specify Bound Brook Oil-less Bearings, for Bound Brook offers you a bearing specifically designed for every application. *Where high shaft speeds and minimum friction are the prime requirements, COMPO Porous Bronze Bearings are consistent winners. Or, to combat shock loads as well as friction, it's hard to beat POWDIRON Sintered Iron Bearings for heavy-duty installations where tensile strength is the principal factor.* Both POWDIRON and COMPO bearings are available in sleeve, flange and self-aligning types in a wide range of alloys and sizes for every known application. Write or phone your nearest Bound Brook Man.

BOUND BROOK

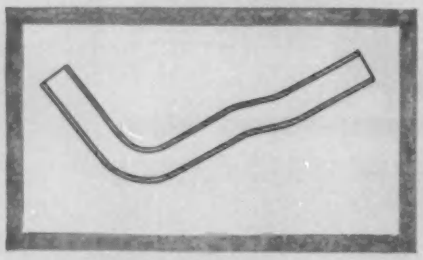
BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in

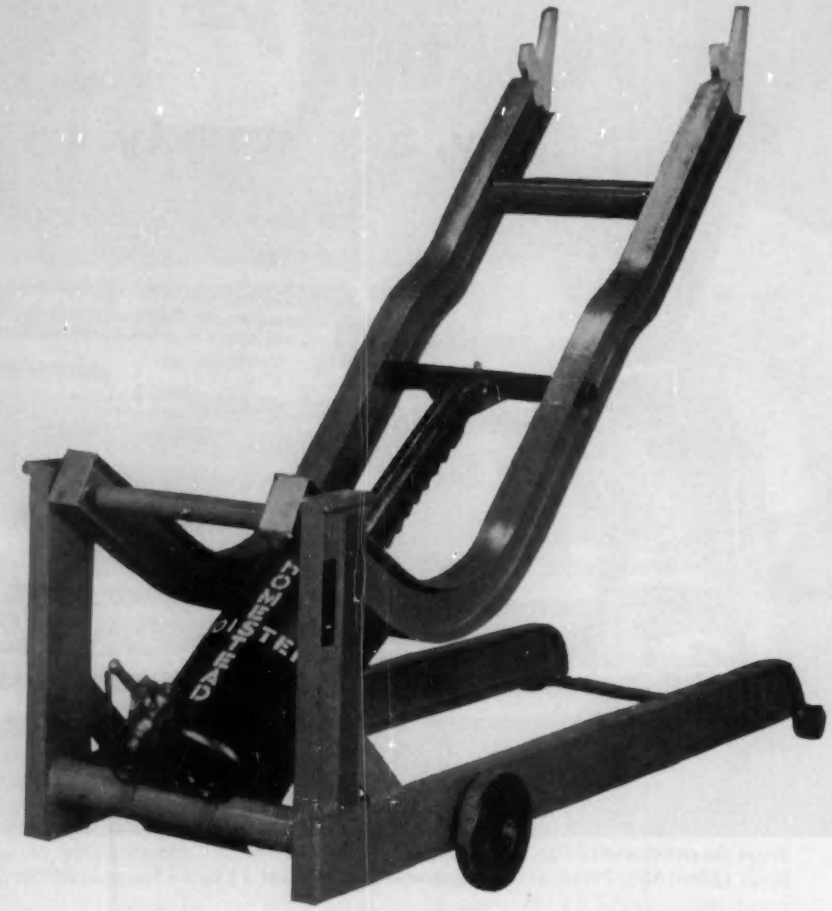
POWDER METALLURGY BEARINGS & PARTS



Change from built-up sections.....



to Bethlehem bent beams..



saves money for manufacturer of air-lift

The air-lift shown above is used primarily for raising cars and trucks in order to make repairs underneath. The arms of the lift are made of two Bethlehem beams, cold-bent to the desired shape.

Previously, this manufacturer made the lift arms from several steel sections welded together to approximately the same shape. By using Bethlehem bent beams, the manufacturer eliminated welding, making a lighter product, trimmer in appearance—and saved money in the bargain.

Bent beam work is a good example of the almost unlimited special shapes Bethlehem is equipped to turn out. For in addition to bent beams, Bethlehem produces a complete range of cold-formed shapes made from strip, sheet or plate steel, in any gage from 5 to 24, inclusive.

The nearest Bethlehem sales office stands ready to furnish you with complete details on bent beam work or any other cold-formed product that you may need. Our representative will be glad to call on you and discuss your needs in detail.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

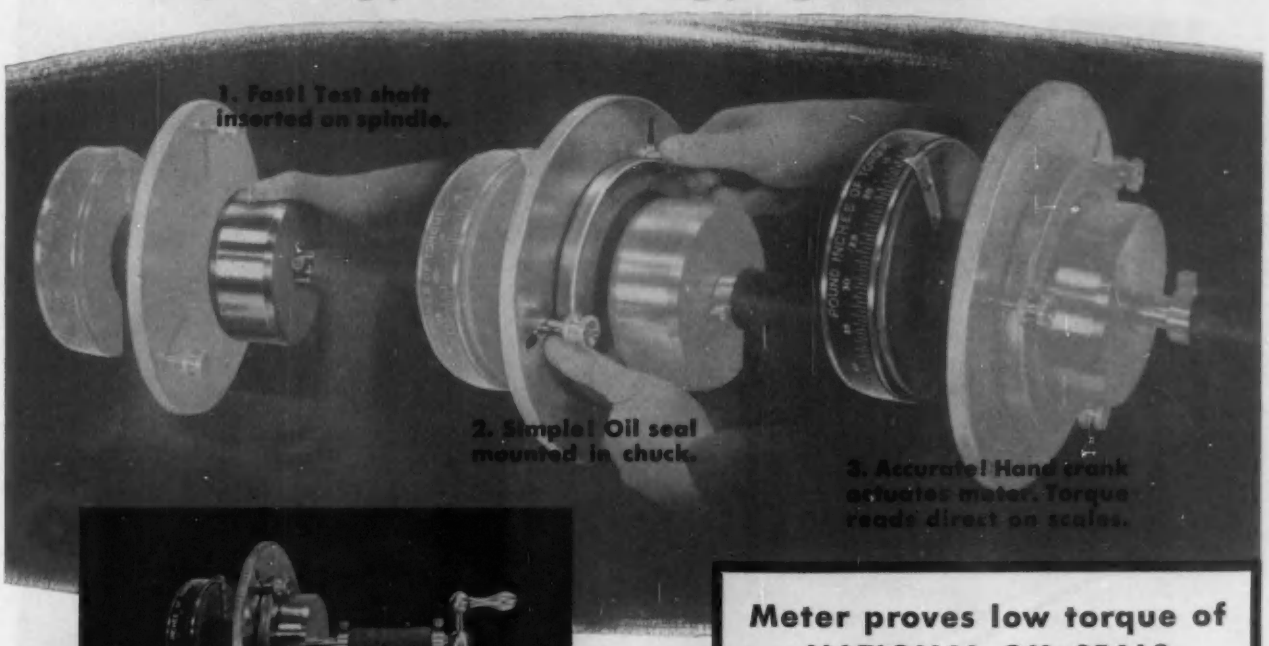
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

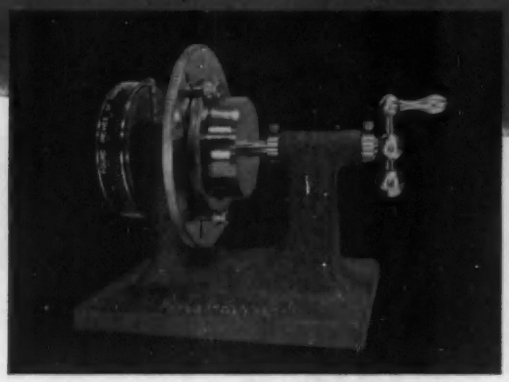
BETHLEHEM STEEL

BETHLEHEM STEEL

Now! MEASURE OIL SEAL TORQUE

quickly, accurately, by hand!


1. Fast! Test shaft inserted on spindle.
2. Simple! Oil seal mounted in chuck.
3. Accurate! Hand crank actuates meter. Torque reads direct on scales.



New NMB Portable Torque Meter

For years, industry has needed a fast, accurate means of measuring oil seal torque for standards determination or during quality control and parts inspection.

The new NMB Portable Torque Meter offers laboratory accuracy for such measurements, yet is rugged, fool-proof, and easily used by production line or receiving department personnel. A minimum of operator training is required; readings are instantaneous and direct.

Two models are offered. Model 615 reads torque to 15 lb. in. on seals from ¾" to 6" diameter; Model 845 reads torque to 60 lb. in. on seals from 2¾" to 8" diameter. Both have a simple, self-centering chuck which accurately positions the seal, and employ standard tapered shafts (special to order). The meters are lightweight (about 27 lbs.) and quality built for years of dependable service. A carrying case is available.

Meter proves low torque of NATIONAL OIL SEALS

National Torque Meters give quick, convincing proof that National Oil Seals have lowest torque.

National Micro-Torc Leather Oil Seals have appreciably less torque than conventional leather seals. National Syntech® synthetic rubber seals also test materially less torque than ordinary synthetics.

Micro-Torc seals achieve their remarkably low torque from a high lubricity coating applied to the surface of the sealing member. (Inside of sealing member retains natural porosity and stores oil for semi-starved operation.)

Syntech Oil Seals have the famous National "minimum-contact" sealing lip which, combined with precision tensioning, insures the lowest torque consistent with effective sealing.

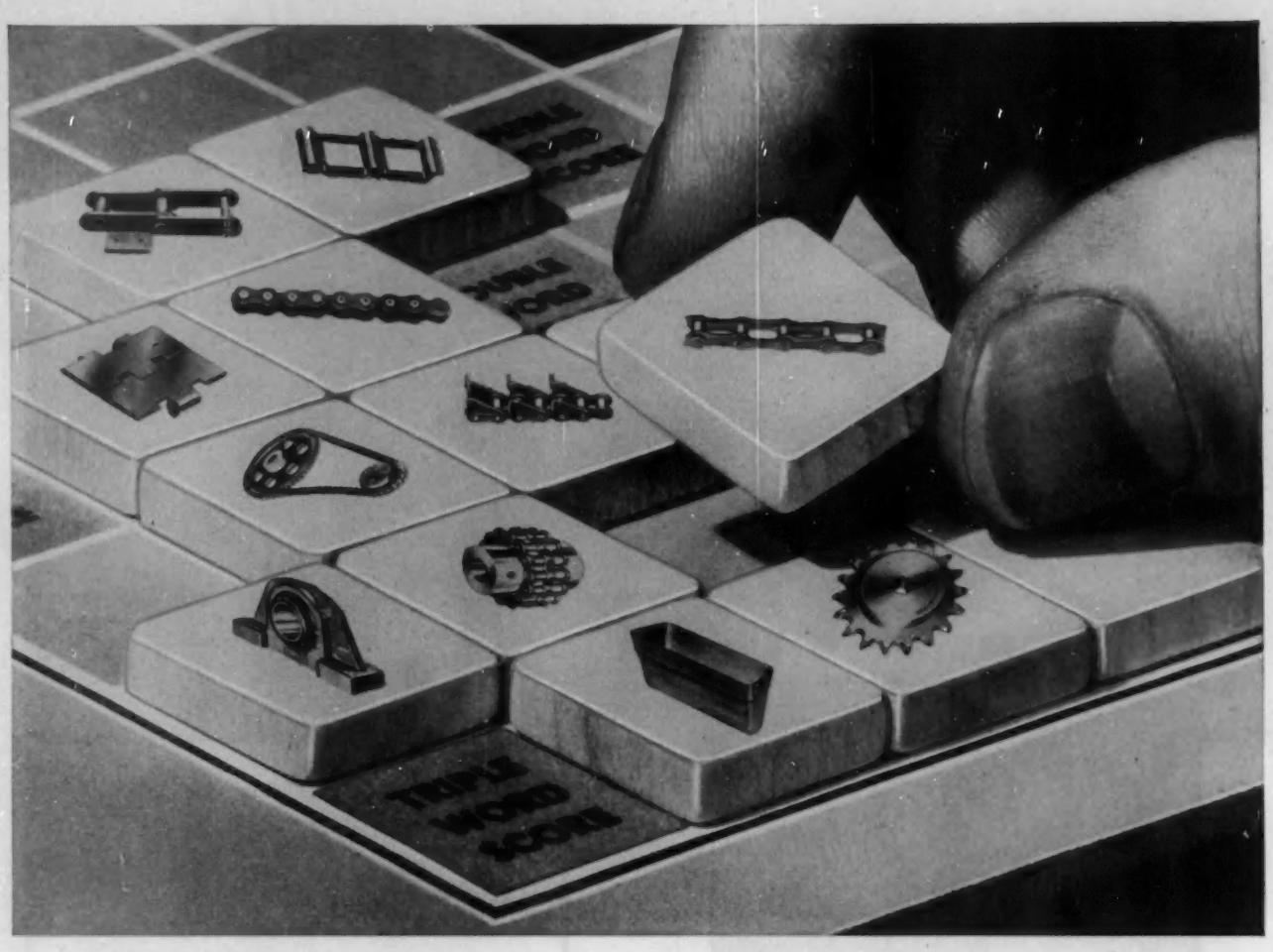
NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif., Downey (Los Angeles County), Calif., Van Wert, Ohio

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS
®

Call in a National Field Engineer

CHICAGO, ILL. . . . *Room 4113 Field Building, FRanklin 2-2847*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpaz 2-8166*
INDIANAPOLIS, INDIANA . *2802 North Delaware St., WAlnut 3-1535*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF. . . *Broadway and National, EMerson 6-3861*
WICHITA, KANSAS . . . . *519 South Broadway, WIchita 2-6971*



SCORE HIGH...in cutting costs!

If you're keeping a close eye on costs when designing your machines, here's a suggestion that has won some important cost battles. Make use of the *complete* CHAIN Belt line and the specialized application services of your CHAIN Belt Field Sales Engineer.

for example: Low cost competition was affecting sales of a packaging machinery manufacturer. Their CHAIN Belt Man suggested a switch from standard roller chain to double-pitch roller chain with standard attachments. This switch reduced over-all cost and actually improved performance without sacrificing efficiency.

for example: A manufacturer of heat treating ovens was having difficulty handling small metal parts through the oven. His CHAIN Belt Man suggested the use of Rex TableTop® Chain. The flat, level TableTop links provided the ideal carrying surface... and at far lower cost than the previous chain and attachments.

for example: A paper-coating machine manufacturer was experiencing difficulty due to variance in the speed of the rollers. By recommending a single roller chain drive instead of a number of individual gears, the CHAIN Belt Man was able to help solve the timing problem . . . and at a far lower cost.

If you have a problem of designing for lower cost, or improving efficiency or appearance, consult your CHAIN Belt Man. Fit into your board the *complete* CHAIN Belt line with the exact chain, attachment, sprocket, flexible coupling or self-aligning bearing to solve your particular problem. Call or write CHAIN Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wisconsin.

CHAIN BELT COMPANY

District Sales Offices and Distributors in all principal cities

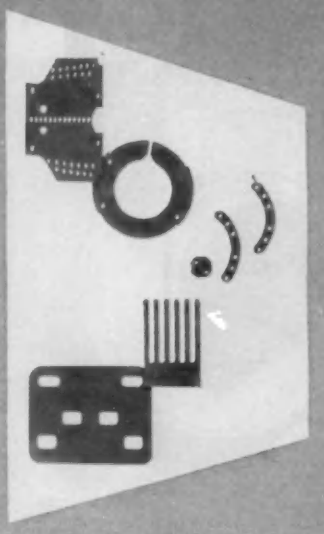
ONE OF THESE THREE

might be your answer to better insulation at lower cost

DUROID 800

PLAIN

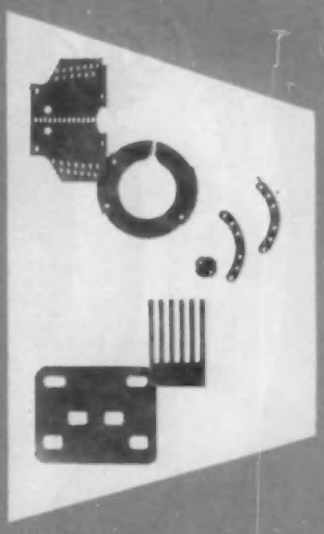
Fibrous sheet material for use as replacement for paper-base laminates where moisture absorption is not a critical factor. Arc resistance, tensile and impact strengths of DUROID 800 are greater than XP paper-base laminates. Listed by Underwriters' Laboratories.



DUROID 800

COATED

Moisture pick-up almost as low as paper-base laminates; flexural strength much higher. Specific coatings — such as alkyds, epoxies and vinyls — can be applied to obtain characteristics available only in much more expensive materials.



DUROID 800

FLAME-RETARDANT

Retains more physical strength after exposure to flame. Self-extinguishing, with no afterglow. Easy to fabricate. Your tests may prove it satisfactory for applications now using much more expensive materials.

For technical data or samples of any of the above materials, please write Dept. E, Rogers Corporation, Rogers, Connecticut.

ROGERS CORPORATION

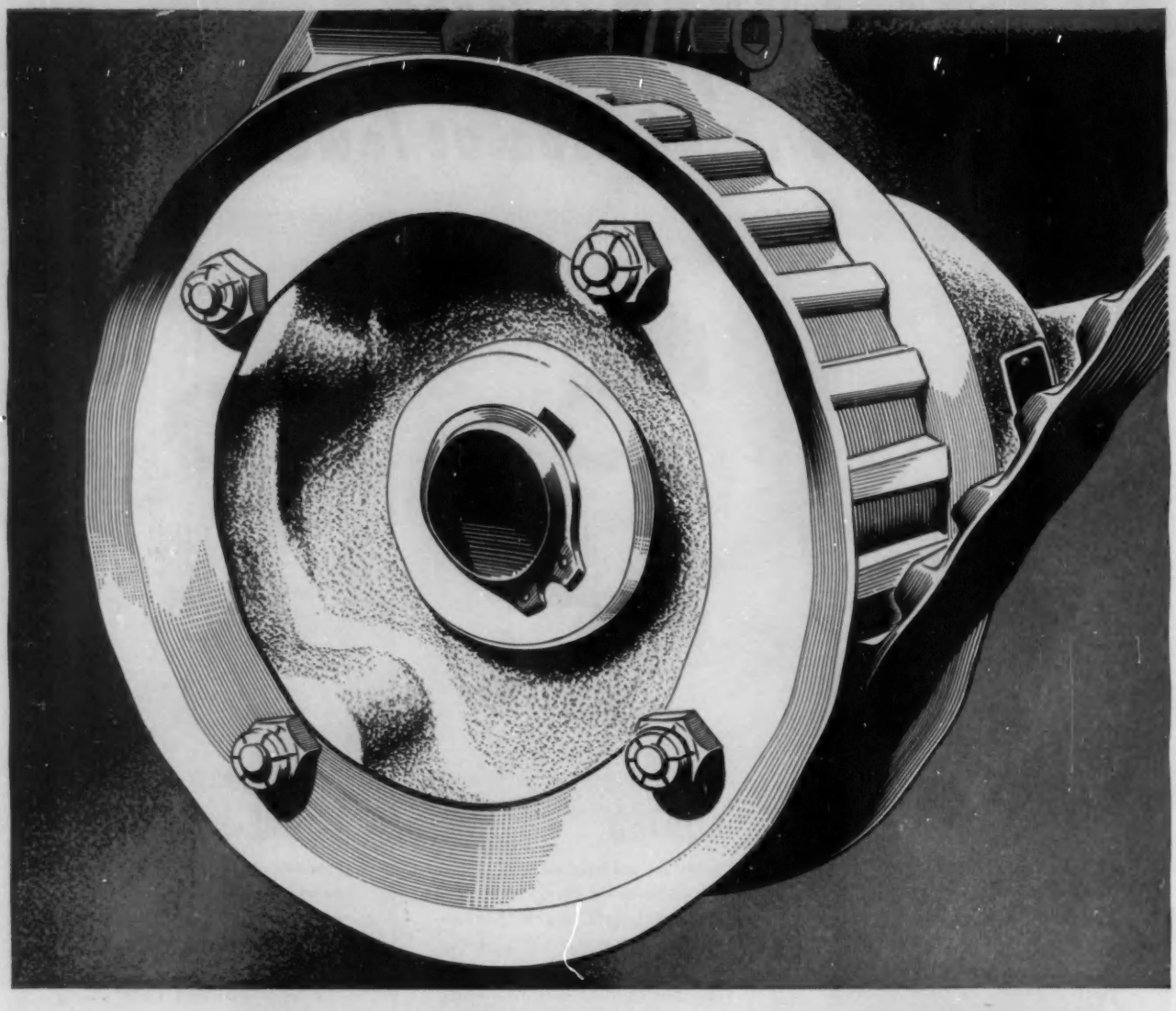
ROGERS, CONNECTICUT

PRODUCTS

DUROIDS—for Gaskets, Filters, Electronic Devices, etc.
SHOE MATERIALS—for Counters, Midsoles, Liners, etc.
ELECTRICAL INSULATION—for Motors, Transformers, Generators, etc.
PLASTICS—Special Purpose Molding Compounds and Laminates

SERVICES

Research, Development, and Engineering of New Materials, Parts and Products • Fabricating, Combining, Coating, & Embossing



MORE AND MORE FLEXLOC LOCKNUTS are being used to hold assemblies like this one together. This modern timing belt drive combines the flexibility of a steel cable belt with the positive action of a silent chain drive permitting its use at speeds up to 15,000 rpm.

FLEXLOC Self-Locking Nuts offer the same positive action as the drive. Once the locking threads are fully engaged, the nuts won't work loose, regardless of the vibration encountered. And FLEXLOCS are reusable.

FLEXLOCS are available in a wide range of sizes in any quantity. Stocks are carried by leading industrial distributors everywhere. Write for Bulletin 866 and samples for test purposes. STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

DO YOU KNOW? Standard FLEXLOCS clean rough threads on bolts, and make them even better. The locking threads on all-metal FLEXLOCS are not chewed up when used on rough bolts.

Standard FLEXLOCS lock securely on bolts varying in diameter tolerances. The all-metal, resilient locking sections of the nut accommodate themselves to the diameter tolerances.

Standard FLEXLOCS are one piece, all metal. They are not affected by temperatures to 550°F. Nuts lacking these features have a more restricted temperature range.

Standard FLEXLOCS lock securely—stopped or seated—when 1½ threads of a standard bolt are past the top of the nut.

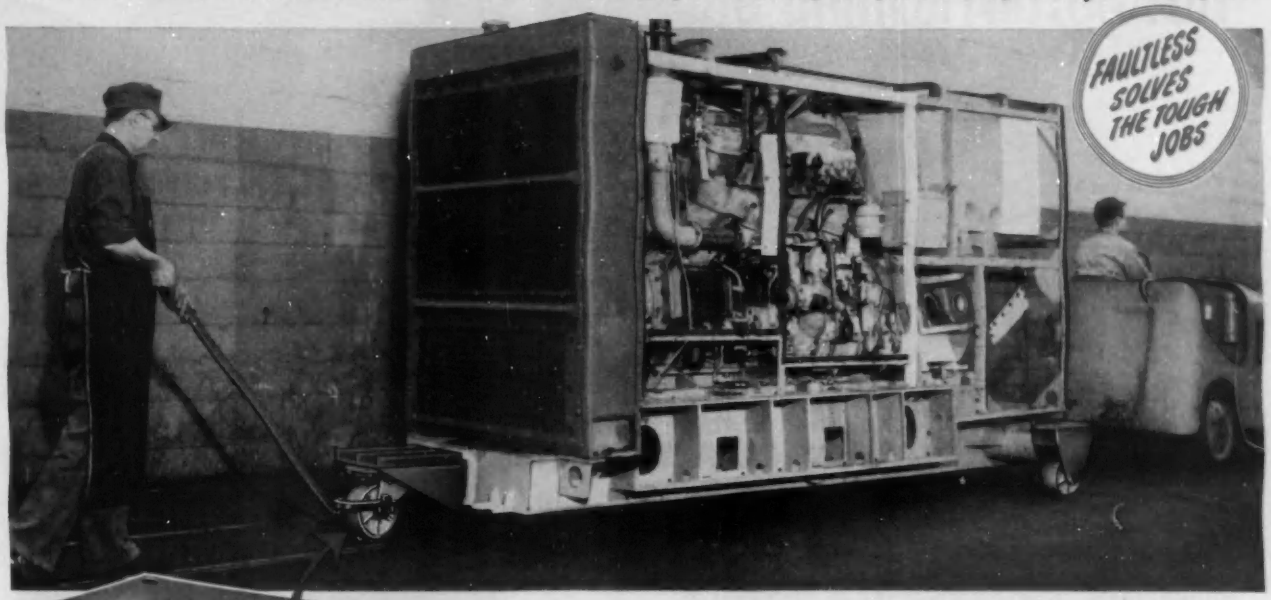
Standard FLEXLOCS are not affected by moisture, oil, dirt or grit. They lock efficiently under all conditions, regardless of the vibration encountered.

FLEXLOC®
LOCKNUT DIVISION
sps
JENKINTOWN PENNSYLVANIA

NOELTING Faultless CASTER MATERIALS HANDLING FACTS

No. 6 in a series of Caster Achievements for men in industry

MOVING 11 TON ENGINE AT CATERPILLAR TRACTOR CO., PEORIA



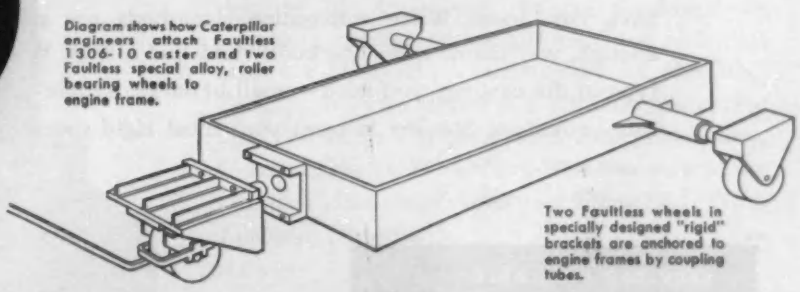
SERIES 1300 SWIVEL LOAD BEARING
4⅜" diam. self-contained, dust-proof, with ½" diam. balls in hardened, ground, polished raceway.

THRUST BEARING
Fits firmly in horn top plate. Unit is interchangeable with wheel bearings.

Maintaining a continuous production-line flow of 22,000 lb. Diesel-electric sets at the Peoria plant of Caterpillar Tractor Co. is accomplished with the aid of Faultless Dreadnaught Casters. Supported on one swivel plate caster, Faultless 1300 Series, and two Faultless wheels in special mountings, the engines are moved a total of approximately 100 feet past production stations situated about 20 feet apart. A small industrial truck pulls the 22,000 pound assemblies through the production area. One man guides the individual units with an ingeniously designed steering arm arrangement on the swivel caster.

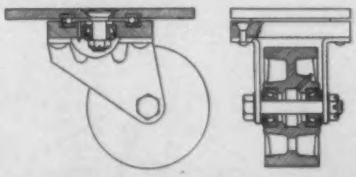
Another unusual materials handling achievement for men in industry, made possible by Faultless Casters.

Diagram shows how Caterpillar engineers attach Faultless 1306-10 caster and two Faultless special alloy, roller bearing wheels to engine frame.



Two Faultless wheels in specially designed "rigid" brackets are anchored to engine frames by coupling tubes.

The FAULTLESS No. 1306-10 Extra Heavy Duty Caster like those used by Caterpillar Tractor Co., Peoria, Ill., on their heavily loaded transfer car.



Castered equipment, from tote boxes to large trucks, help you solve production problems. Whether you need to move 50 pounds of delicate instruments or 15 tons of sheet steel, Faultless makes the casters to best do the job.

Competent engineers, a modern factory, and skilled personnel combine to furnish you the dependable casters you need for your individual operation. Factory-trained representatives and selected distributors are on call to help solve your product engineering problems.

FAULTLESS CASTER CORPORATION
EVANSVILLE 7, IND.
Offices in Atlanta, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Houston, Indianapolis, Los Angeles

we "threw away the book" to make this die casting...

● Thin walls blending into heavy sections made this a tough one . . .
but **Stewart** turns out castings like this in volume

After 45 years, Stewart Die Casting is still young enough to have new ideas. When conventional methods are not good enough, we "throw away the book" and find a way. Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . . **Designing • Engineering • Die Making Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.**

45 years of helping industry to "Make It Better"

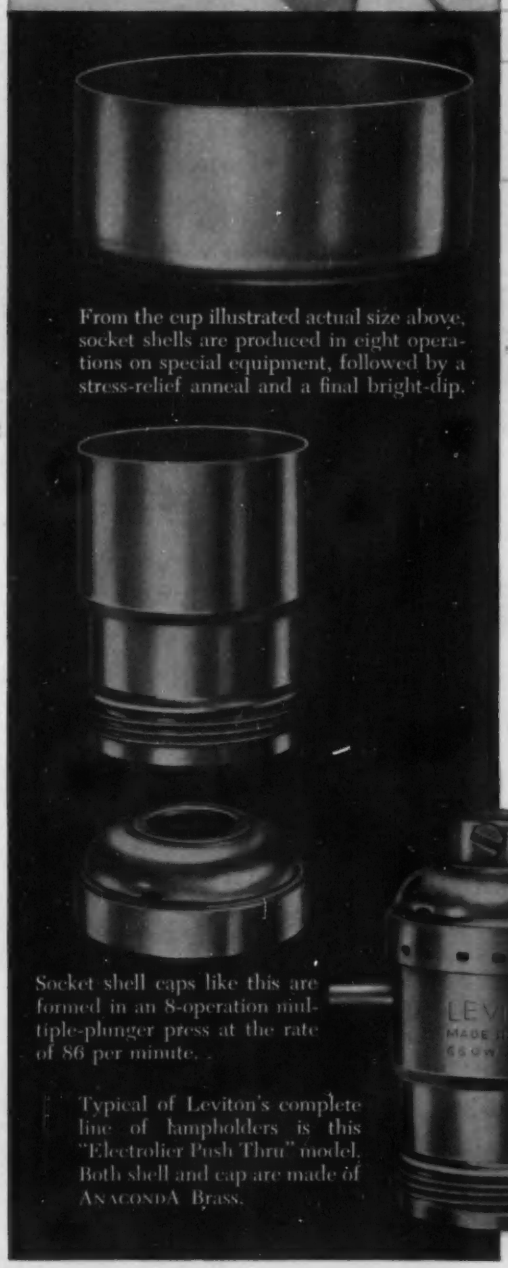
Stewart DIE CASTING

. . . a division of STEWART SW WARNER

CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET

Joe Vuille says it's simple arithmetic:
"180 cups per min. x 60 min. x 40 hours per week x 5 weeks=

2,160,000 brass cups in one uninterrupted run"



From the cup illustrated actual size above, socket shells are produced in eight operations on special equipment, followed by a stress-relief anneal and a final bright-dip.

Socket shell caps like this are formed in an 8-operation multiple-plunger press at the rate of 86 per minute.

Typical of Leviton's complete line of lampholders is this "Electrolier Push Thru" model. Both shell and cap are made of ANACONDA Brass.

For more than 20 years, Joe has been pressroom foreman of Leviton Manufacturing Company, Brooklyn, N. Y., one of the world's largest manufacturers of electrical wiring devices.

Multi-million production runs of stamped and drawn products are nothing new to Joe, but he'll admit that there's more to it than a multiplication table:

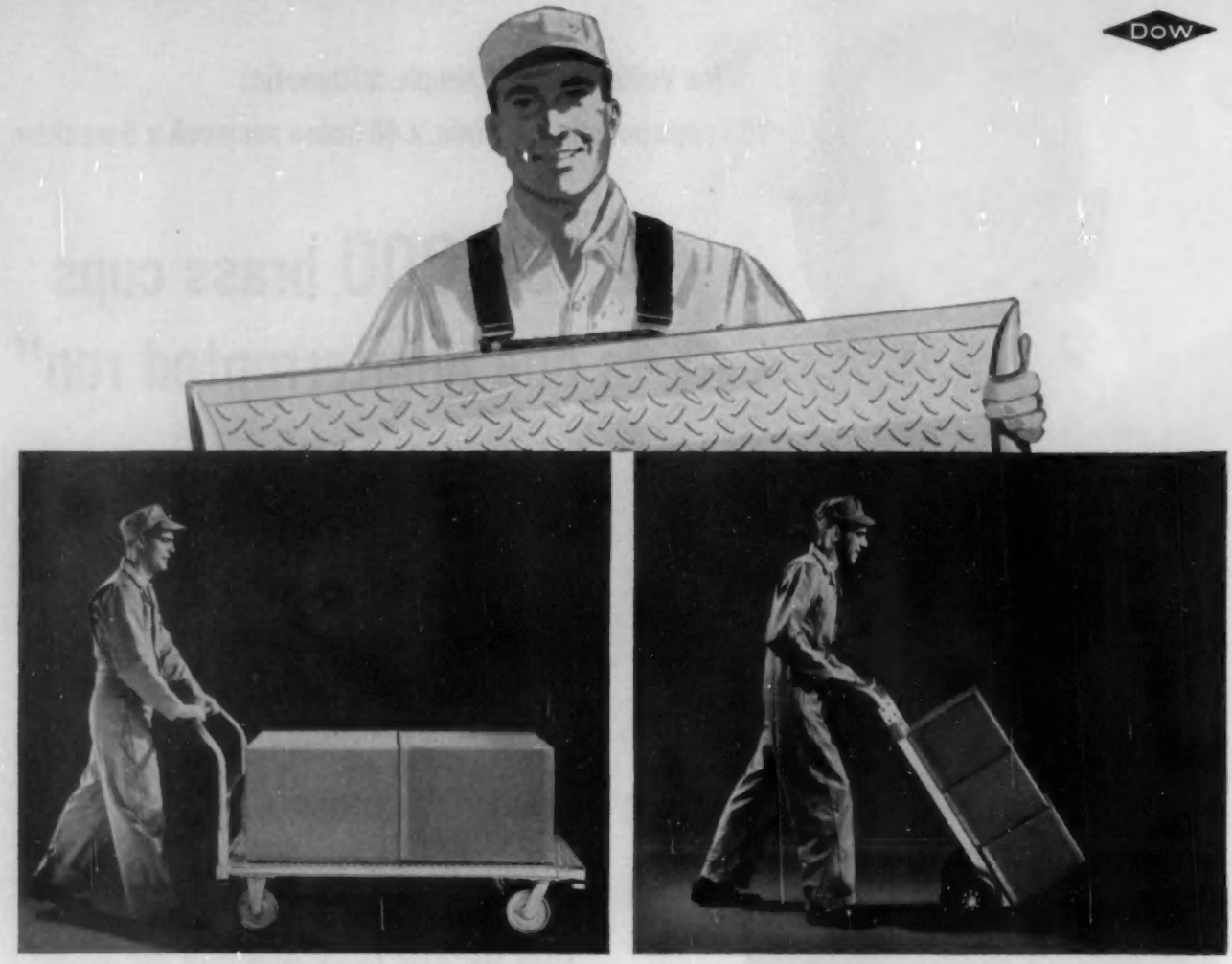
"First," says Joe, "you start with a good product design. Then the toolroom calls on its broad experience in diemaking. Next, good equipment and good housekeeping are essential in the pressroom. And then there's the brass: these extra-large coils of brass strip have to be just so . . . in dimension, composition, grain size, temper and surface finish . . . lot after lot after lot . . . tailor-made for the job."

Each year Leviton uses more than a million pounds of ANACONDA Brass, produced to Leviton's precise specifications, "just so . . . lot after lot after lot . . . tailor-made for the job." Perhaps we can perform a similar service for you? Write to *The American Brass Company, General Offices, Waterbury 20, Connecticut.* In Canada: *Anaconda American Brass Ltd., New Toronto, Ontario.*

You can always depend on

ANACONDA®

copper, brass and bronze



MAGNESIUM

Lightness in equipment saves manpower when materials are on the move

That's why magnesium is being used more and more to build lightweight but rugged materials handling equipment —to save manpower. Dockboards, platform trucks and hand trucks are just a few of the many applications where magnesium's light weight has increased efficiency and saved money.

One fourth the weight of steel, one third lighter than aluminum, magnesium has simplified design problems while maintaining maximum strength required. Fabrication is also made easier by the excellent weldability, forming, drawing and machining characteristics of magnesium.

To the equipment purchaser, "Made of Magnesium" assures peak efficiency in operation. To the equipment manufacturer, magnesium has become the key to more useful products, greater volume and complete customer satisfaction.

For further information about magnesium, call your nearest Dow sales office, or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. MA 317B.

you can depend on DOW MAGNESIUM

DOW

What shape is a quality fastener?

Here is a handful of ELASTIC STOP® nuts. Each has ESNA's familiar red locking collar . . . is self-locking and vibration-proof. Each is a readily assembled, one-piece unit. Each provides positive protection against thread corrosion . . . prevents liquid seepage along bolts. Each is made from the finest of raw materials. Each is exactly controlled as to finished dimensions, class of thread fit and finish. Each is now in use on critical applications, with a record for uniform high quality that is unmatched.

Most of them are standard parts. Some originated as the result of a specific request for ESNA's help with an important fastening problem.

Isn't it logical to call on us with your next fastening problem?

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA TRADE MARK

ROLLPIN TRADEMARK

ELASTIC STOP NUT CORP. OF AMERICA
Dept. N 62-52, 2330 Vauxhall Road, Union, N. J.

Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

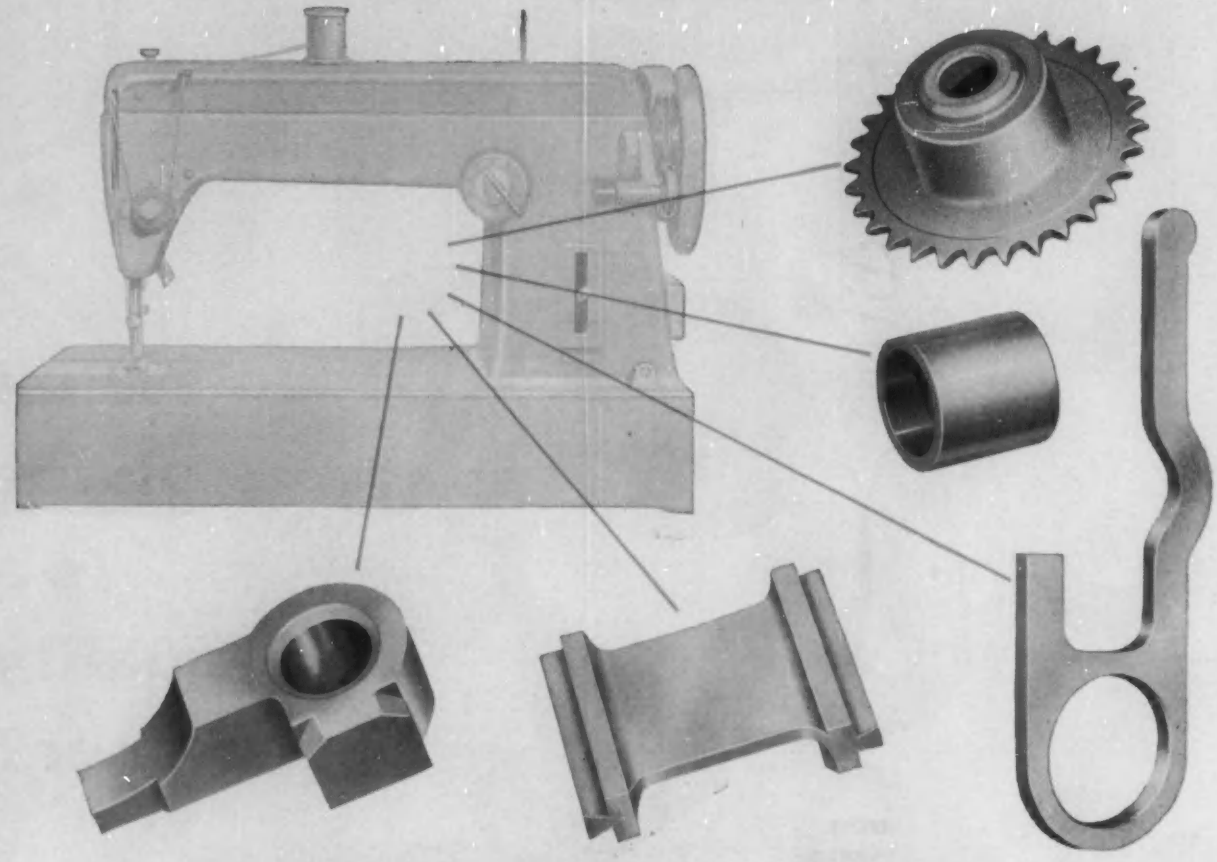
Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

IN POWDER METALLURGY . . . IT'S AMPLEX



Switching to OILITE® helps Make this Manufacturer Competitive

Price competition and rising production costs caused one sewing machine manufacturer to re-examine his component parts to determine how costs could be lowered while maintaining high quality standards.

Super OILITE and Steel OILITE provided the answer. Many parts, including gears, eccentrics and sprockets, were redesigned for production in these high-strength materials. Formed in automatic presses in seconds, these OILITE parts reduced costs substantially by eliminating costly machining operations . . . and high quality is maintained.

The conversion provided another benefit. Certain parts were designed to take advantage of the self-lubricating qualities available in some OILITE materials.

Let Amplex help you with your parts problems. The Chrysler-Amplex engineering facilities, unmatched in the powder metal industry, are ready to serve you. Call or write today.

CHRYSLER AMPLEX PRODUCTS

OILITE Bearings
Permanent Metal Filters
Finished Machine Parts
Friction Units

IT'S NEW! IT'S FREE!

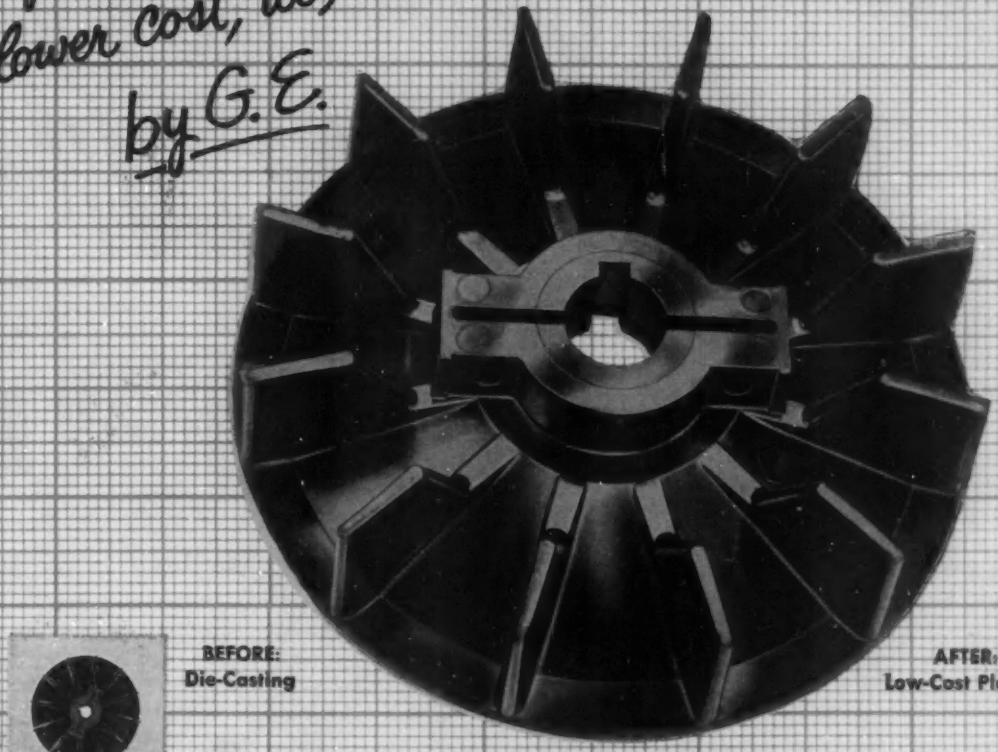
First complete information on powder metal bearings, finished machine parts, filters and special parts. 48 pgs. Write today for OILITE Engineering Manual E-55.

OILITE — *Only Chrysler makes OILITE*

CHRYSLER CORPORATION • AMPLEX DIVISION

Dept. F-5 Detroit 31, Michigan • Overseas Distribution—Chrysler Export

How to make a good product even better (at lower cost, too) with plastics parts by G.E.



BEFORE:
Die-Casting

AFTER:
Low-Cost Plastics

Here is a typical problem handled by G-E Plastics Engineers—a metal cooling fan used in an induction motor. Cost of metal was high and machining operations were substantial. With a wealth of experience in designing plastics products for moving liquids and gases, G-E Plastics Engineers suggested molding this unit from rag-filled phenolic material. Result: A new and more efficient part which eliminated machining and greatly reduced the cost of the finished product.

Are you a manufacturer of high-volume parts or products?
If you are, it is very likely that General Electric's experience in applying molded plastics can make a technological contribution that can cut your costs or improve your design. We'd like to discuss your particular problem with you.

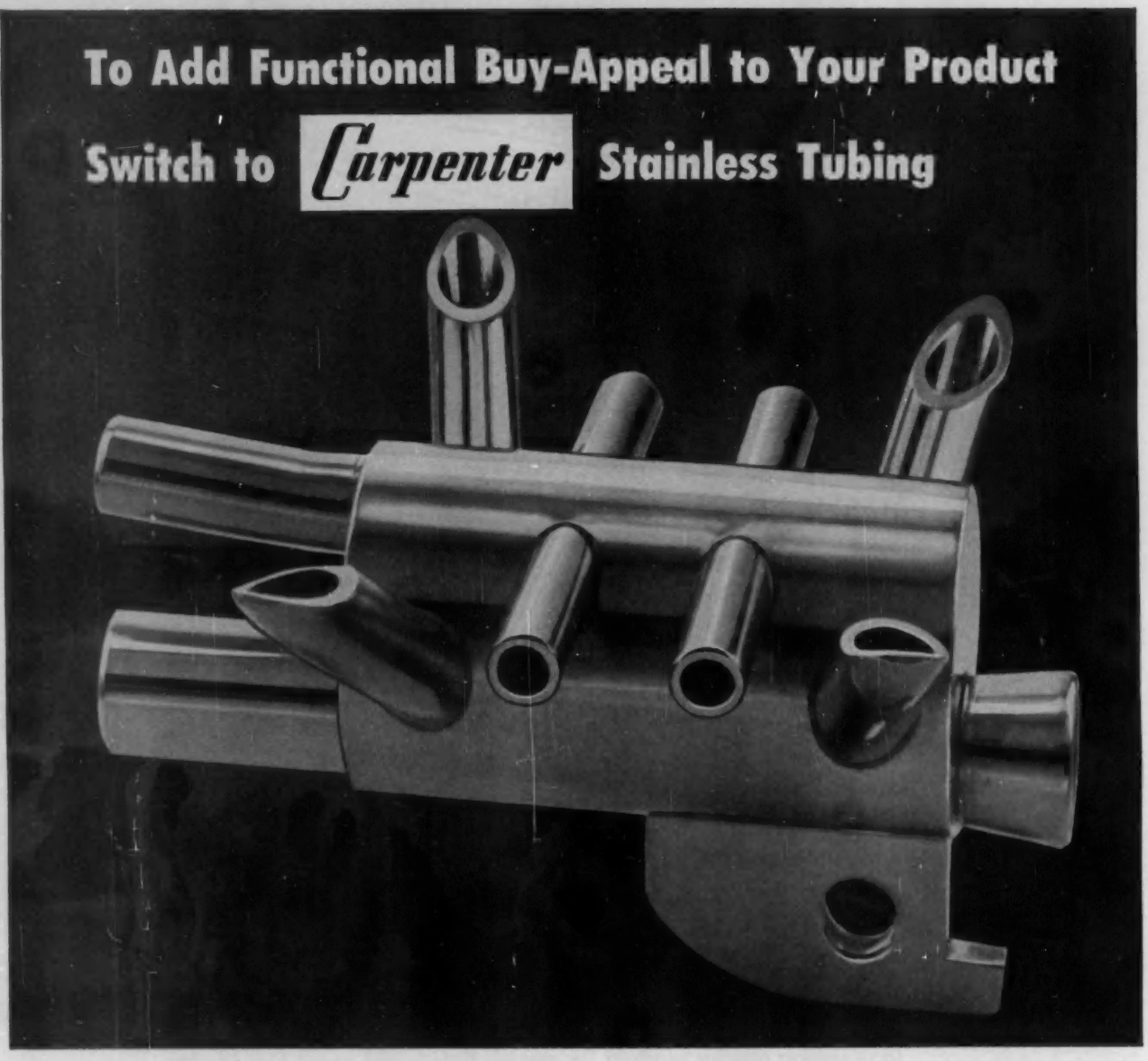
Write: Plastics Department, General Electric Company, Pittsfield, Mass.
Plants at Decatur, Illinois—Taunton, Massachusetts 450-8B

Progress Is Our Most Important Product

GENERAL ELECTRIC

To Add Functional Buy-Appeal to Your Product

Switch to *Carpenter* Stainless Tubing



Appearance is important to any product, of course. An example is the milking machine manifold shown above. But there are more reasons for specifying Carpenter Stainless than its shining beauty.

Long-life and corrosion resistance, for example—excellent strength for weight ratio, workability, ease of machining, brazing and welding. And when you call for Carpenter you get some important "extras". *Uniformity* of dimension, analysis, concentricity from length to length and order to order is one of them. Another is Carpenter's *availability*. Adequate distributor stocks in key areas coast to coast, plus Carpenter's "cross stock availability plan" insures delivery of the tubing or pipe you need, when and where you need it.

For more complete information on Carpenter Stainless Tubing and Pipe, write today for the new Condensed Data File. It contains data on physicals, analyses, dimensions, weights, tolerances and fabrication.

The Carpenter Steel Company, Alloy Tube Division, Union, N.J.
Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

Carpenter
Stainless Tubing & Pipe

Try this when you want something BIG in plastics

This large-sized plastic section is made from BAKELITE Brand High-Impact Styrene TGD-5001. It's tough. Its glossy surface is free from grain. It's intricately detailed—shaped by vacuum-forming—a fast, easy, low-cost production method.

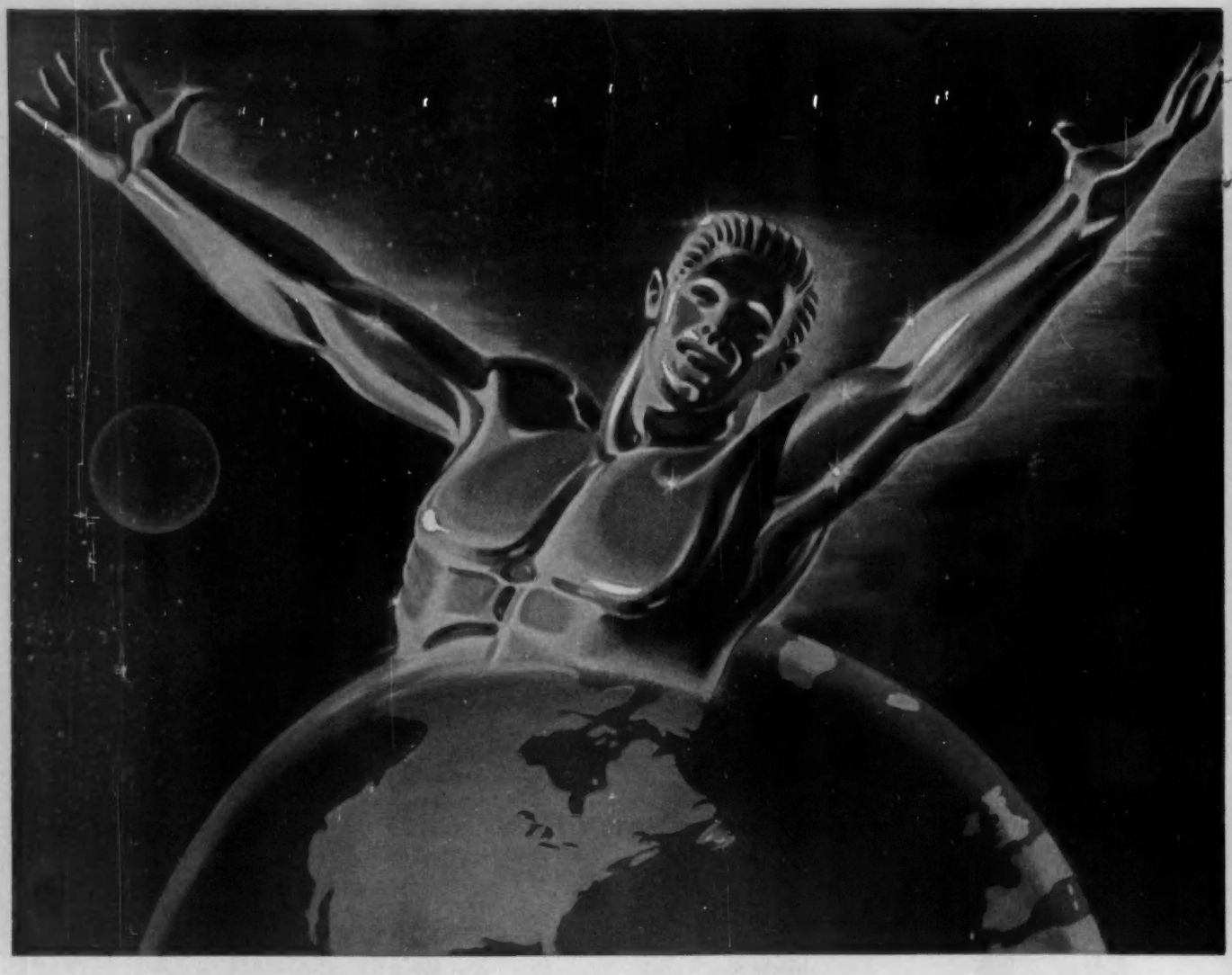
TGD-5001 is specifically formulated for extrusion into sheets to be postformed later. Your plastics fabricator can extrude sheets of TGD-5001 with a gloss that is retained during subsequent vacuum-forming. In addition, TGD-5001 offers a wide range of brilliant colors for which styrene plastics are noted.

Refrigerator door panels, toys, display stands, and housings for air conditioners are typical of the products that can benefit from the combination of serviceability, eye-appeal and production advantages found in BAKELITE High-Impact Styrene TGD-5001. Write Dept. HB-145 for further information.

Measuring 26 inches wide, 49 inches long, and 2½ inches at its deepest part, this refrigerator inner door panel typifies the large-sized, tough products that can be vacuum-formed from BAKELITE High-Impact Styrene TGD-5001. It was produced by **General American Transportation Co.**, Chicago, Ill.

BAKELITE BRAND High-Impact Styrenes

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC



NEW DAY COMING FOR WEIGHT-SAVERS!

For example . . . you can reduce the weight of a part as much as 44% with Republic Titanium, yet not sacrifice a single pound of tensile strength.

Or . . . if you require additional strength, use Republic Titanium to gain it without adding weight to the part.

You've probably thought of Titanium as "one of those rare metals only the aircraft industry can get . . . or afford." And that has been the case, in the past.

But Republic Steel and other producers of Titanium are steadily increasing their facilities, as well as improving their processes and products, looking toward the time when there should be Titanium for almost everybody. You'll be foresighted to learn now what Republic Titanium Alloys can do for your product, and you, tomorrow or a year from now . . . or perhaps as long as five years hence.

Republic Steel is an old hand at this high strength-to-weight business. For a quarter century we've been helping customers design and engineer strong steel alloys and stainless steel into parts that need more strength without extra "beef", or extra rigidity without excess pounds. That's why Republic can offer you unbiased recommendations on any metal problem. Where Republic Titanium will be best, we'll say so . . . where a Republic Alloy Steel or Stainless Steel will do the job better, that's our suggestion.

The coupon below will bring literature to give you a head start on Republic Titanium over competitors. Mail it today.

REPUBLIC STEEL

...ready with the answers to your strength-to-weight problems...

One man's problem may call for alloy steel . . . another's a stainless steel . . . and a third's a special carbon steel . . . all made by Republic. At Republic, we roll more types of steels and make more types of steel products than any other producer. From decades of experience with many problems and many fabrication processes, the Republic Technical Man can hand you the answer that meets your needs.

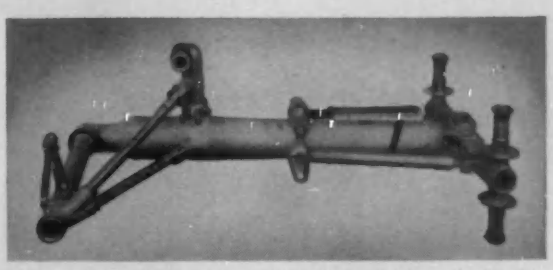
Whether your product must move lightly, stand still, look beautiful, or fight corrosion . . . the Republic Technical Man and his background of experience are prepared to serve you.

The coupon below will bring you information about Republic Titanium, Republic Stainless Steels, and Republic Alloy Steels.

REPUBLIC STEEL

World's Widest Range
of Standard Steels and Steel Products

LATEST FACTS ABOUT REPUBLIC TITANIUM



WHAM! EVER THINK OF THE TREMENDOUS STRAIN on the landing gear when the huge aircraft you are in hits the runway at high speed? Don't worry, the landing gear can take it. Republic Alloy Steels provide the high strength and toughness needed to withstand high impact and heavy loads in aircraft landing gear—provide the hardenability to resist wear on bearing surfaces.

REPUBLIC HIGH STRENGTH STRUCTURAL BOLTS provide a new, fast, economical way to fasten structures permanently. Bolting reduces noise. Replaces field riveting. Is often safer and easier than other methods. Work usually is done from within structure, eliminating costly scaffolding. Made in accordance with ASTM Spec. A325. Bolts marked for easy identification to conform to Spec. for Assembly of Structural Joints, 2-27-54, Research Council on Riveted and Bolted Construction.

SAVE UP TO 25% IN WEIGHT, EVEN 50% with Republic High Strength Steel. Yes, when you engineer earth moving equipment, truck and gasoline trailers, railroad cars, and other mobile equipment to take full advantage of the high strength, low weight and corrosion-resistance of Republic High Strength Steel, you can cut weight up to 50%. And you can lengthen equipment life, too.

REPUBLIC STEEL CORPORATION
3150 East 45th Street
Cleveland 27, Ohio

Please send me more information on:

☐ Titanium ☐ High Strength Bolts
☐ High Strength Steel ☐ Alloy Steels

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

R-6201

FACT: Mounted where it does not take up valuable machine space, the new, totally-enclosed Westinghouse d-c braking controller now stops this 250-ton vertical press in 5% of former time—without need of any special motors, shaft extensions, mechanical braking devices or special windings.

FACT: The new Westinghouse d-c braking controller contains all controls necessary for normal starting and stopping, including motor overload protection, plus the d-c braking unit with its self-contained source of d-c current. Requires minimum maintenance.

FACT: Now it takes just 24 seconds to stop this vertical press, driven by a 25-hp motor—where it formerly took eight minutes. Westinghouse d-c braking can stop motors of 7½ hp or less—under normal load—in one second.

FACT:

New d-c braking controller stops a-c motors in seconds!

FACT: Decelerating the flywheel on this 250-ton, single-acting vertical press—for tool changes, emergencies—used to take eight long minutes. The new Westinghouse d-c braking controller now does it in just 24 seconds.

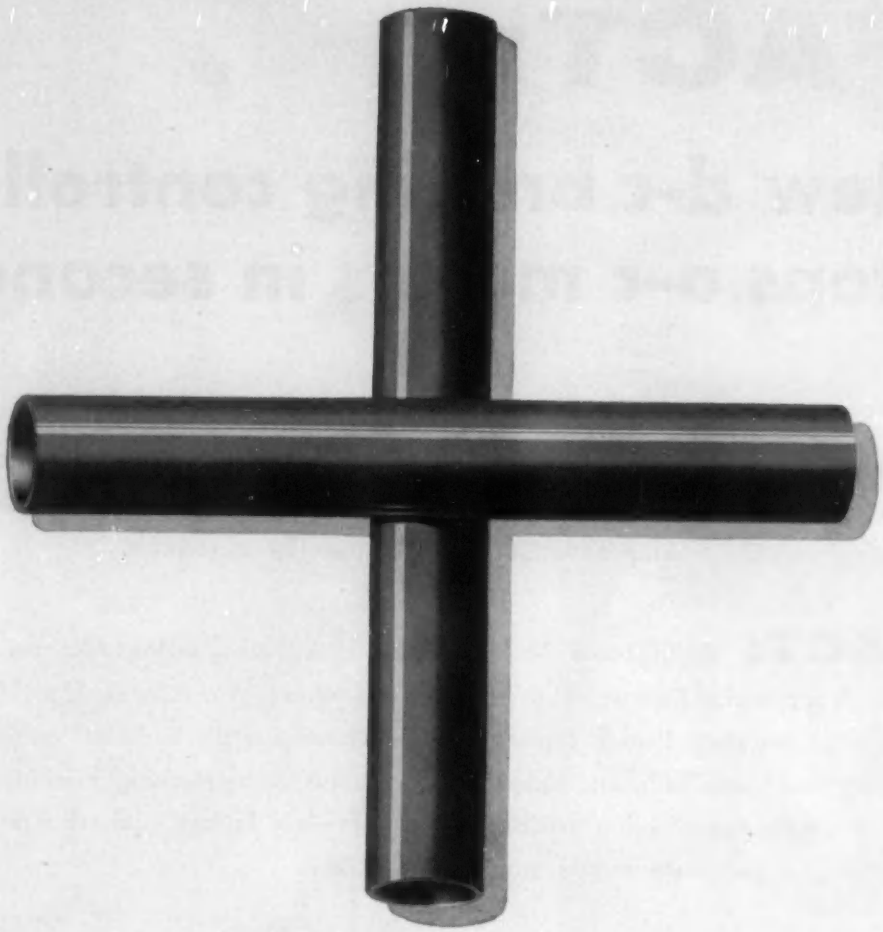
FACT: Westinghouse d-c braking can contribute a savings like this in valuable production time wherever automatic operation is geared for rapid and/or controlled stopping. Typical applications involve radial drills, hydraulic presses, tapping machines, automatic lathes, machine tools, woodworking machinery, textile machines, packaging machines, conveyors—and include squirrel-cage or wound-rotor polyphase motors, single-phase motors.

FACT: Deceleration with the new Westinghouse d-c braking controller is smooth, without vibration, and without shock to the drive—also without reverse rotation or a holding torque at the end of the braking cycle. And no controller adjustments are necessary once the original "stop" cycle is determined.

Get the complete story on how Westinghouse d-c braking can help you cut nonproductive work time. Call *The Man With The Facts,* the control sales engineer in your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30182

YOU CAN BE SURE...IF IT'S

Westinghouse



The Big Plus in Tubing

Remember
GM STEEL TUBING
By Rochester Products

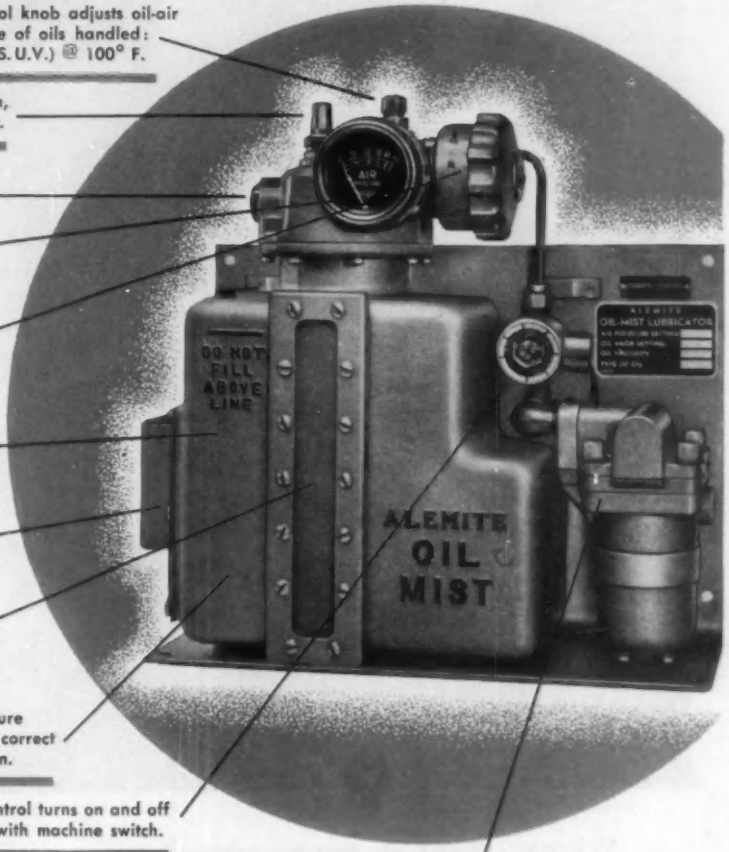
GM STEEL TUBING BY ROCHESTER PRODUCTS, DIVISION OF GENERAL MOTORS, ROCHESTER, N.Y.

You asked for it!
Designers told us what industry had to have!

ALEMITE OIL-MIST

Proved in countless applications – multiplies bearing life – slashes product spoilage – boosts machine output!

Hundreds of case histories prove savings, ease of installation, increased output with Oil-Mist. And Oil-Mist is simple to design into any machine. Oil-Mist applies a constant, clean, cool film of oil uniformly to working parts – vees, chains, slides, gears, all types of bearings. Replaces grease systems. No moving parts – operates on compressed air – completely automatic, fool-proof!



1. Oil flow control knob adjusts oil-air mixture. Range of oils handled: to 1,000 sec. (S.U.V.) @ 100° F.
2. Loader fitting for fast, clean, filtered refilling of reservoir.
3. Oil-Mist delivery outlet for main line leading to bearings.
4. Air gauge registers to 50 psi.
5. Air regulator—operating pressure 5 to 20 psi. Reduces pressures from up to 200 psi. Normal air consumption, .7 to 1.2 cfm.
6. Reservoir capacity one gallon. Also available in 12 oz. size.
7. Low level indicator switch turns on warning signal or stops the machine when oil level is low.
8. Nylon plastic window gives visible check of oil supply.
9. Heater for outdoor or low temperature applications. Thermostat keeps oil at correct temperature for efficient atomization.
10. Solenoid air control turns on and off simultaneously with machine switch.
11. Moisture separator and filter removes up to 98% of moisture from incoming air at flow rate up to 1 cfm.

Complete range of models and multiple unit models to fit any machine – any application

Three types of bearing fittings allow the use of OIL-MIST on any machine!

Oil-Mist fittings bring the most efficient lubrication in the world to any anti-friction bearing—roller, ball, needle.

Spray fittings are recommended for open and enclosed gears and chains. Allow for a concentrated spray of oil where needed.

Condensing fittings apply oil in liquid form to plain bearings, slides, ways, vees, cams and rollers.

Alemite Oil-Mist offers these lubrication advantages

Automatic lubrication • Continuous lubrication
Eliminates guesswork • Greater safety • Cuts oil consumption up to 90%
Extends bearing life • Stops oil drippage • Saves man-power
Reduces number of lubricants needed • Eliminates "Down-time"

FREE ... *write today!*

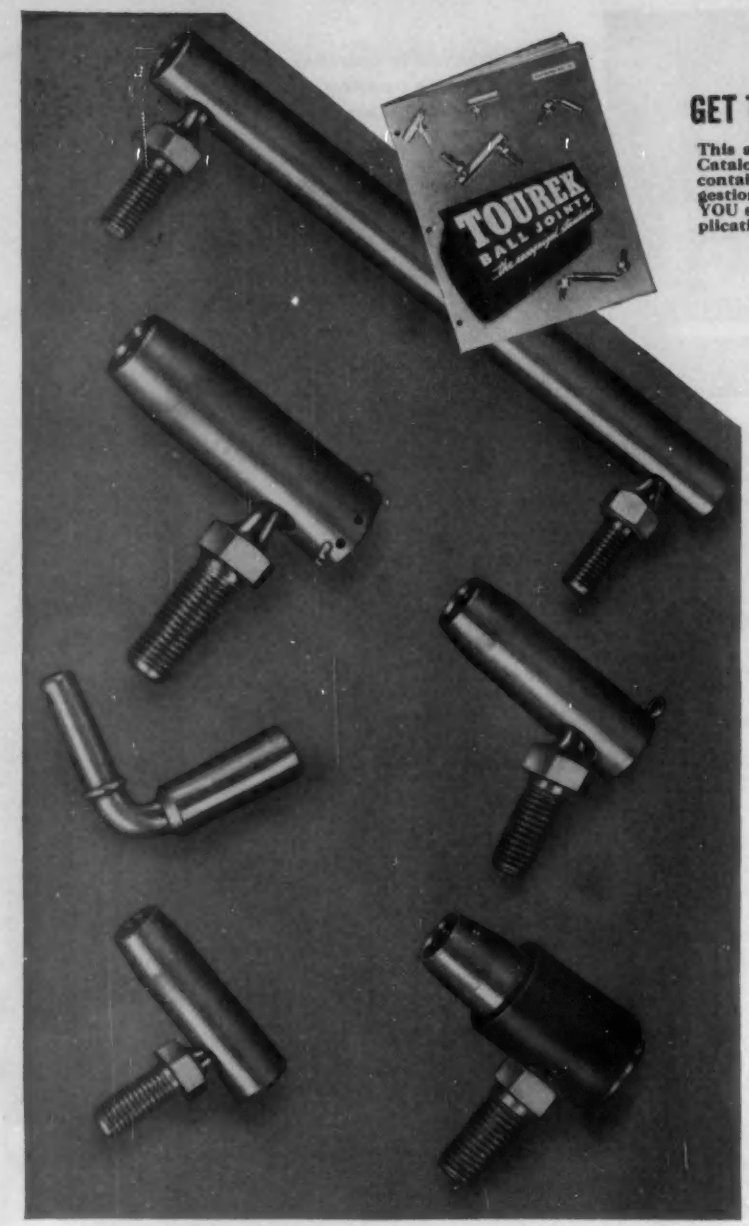
Use coupon below for your free copy of the Oil-Mist catalog and data book!

Alemite, Dept. T-55, 1850 Diversey Parkway, Chicago 14, Illinois

Name .....
Company .....
Address .....
City ..... State .....

ALEMITE OIL-MIST LUBRICATION

A PRODUCT OF SW STEWART WARNER



GET THIS *Free* 16-PAGE BALL JOINT GUIDE!

This attractively printed 16-page TOUREK Ball Joint Guide-Catalog will be mailed to you without cost or obligation. It contains pictures, diagrams, cross sections, tables, ideas, suggestions and other technical data especially designed to help YOU specify exactly the right Ball Joints for your specific applications. Send for your copy today!

Tourek

EXTREME UNIFORM ACCURACY IN SCREW MACHINE PRODUCTS

standard ball joints

..recognized leaders *for* 31 years!

TOUREK "Standard" Ball Joints have long enjoyed an enviable reputation. They are widely known among critical buyers as *"the recognized standard"* by which others are judged.

31 years of specializing . . of developing and perfecting methods and machines are responsible for the UNIFORM accuracy of these better Ball Joints. Whether you need hundreds or thousands, you can depend upon TOUREK, with complete assurance, for a degree of precision which assures, for you, speedier production, lower costs, improved product performance!

If you need "standard" or special Ball Joints, or the fast, economical production of any type of SCREW MACHINE PRODUCT, you'll profit by turning to TOUREK for speedy service and cooperation. Extensive facilities and a large, experienced staff are ready, here, to give you ideas, suggestions and cost estimates. Will you tell us, now, just how we can best serve you?

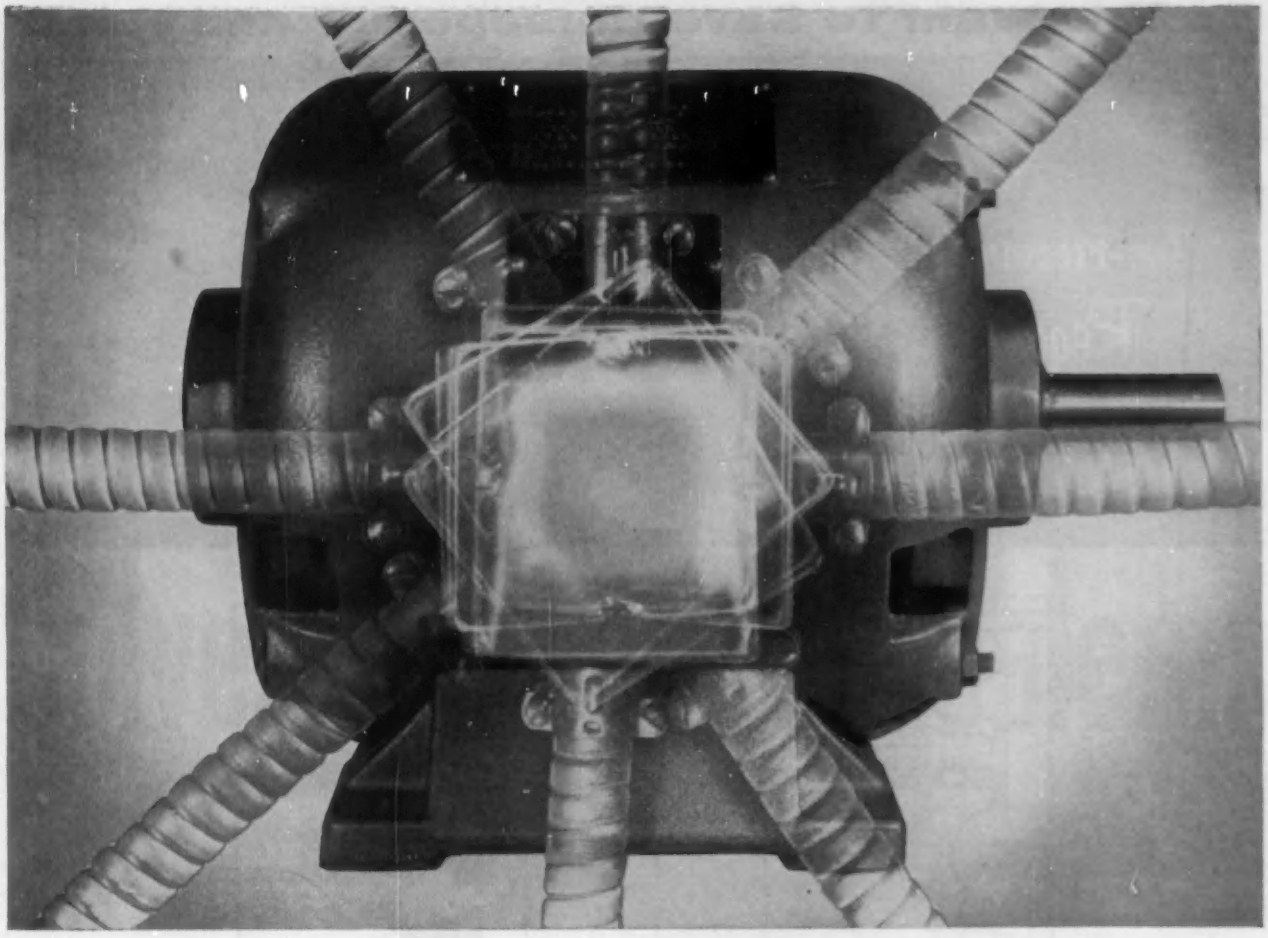
J. J. TOUREK MFG. CO.

ESTABLISHED 1920

1901 SOUTH KILBOURN AVENUE, CHICAGO 23, ILLINOIS

. . UP TO 2-5/8" DIAMETER SINGLE AND MULTIPLE SPINDLE MACHINES . . THREADING • TAPPING • MILLING • DRILLING • GRINDING • POLISHING • PLATING • HEAT TREATING • SILVER SOLDERING •

WORLD'S LARGEST MANUFACTURER OF "STANDARD" BALL JOINTS



Full rotating conduit box

saves space, speeds motor installation

Exclusive with A. O. Smith integral hp motors

This is one of those worthwhile *extras* that's yours only with A. O. Smith integral hp motors.

Think of this full rotating conduit box in terms of your own operations. Because the box can be set at *any* angle, motor space requirements are reduced . . . better product design is made possible. You get production economy, too . . . because box angle can be changed so easily, just by removing the cover and loosening three screws.

Yes, when it comes to integral hp motors, it's good business to specify A. O. Smith. This is the line that gives you performance, matched to your products . . . also offers you common-sense features that pay off in your plant. You get features like full rotating conduit boxes . . . like optional frame mountings which let you use either the old or new NEMA mounting dimensions.

Get all the facts about A. O. Smith integral hp motors — 1 to 150 hp. Write A. O. Smith Corporation, Electric Motor Division, P. O. Box 170, Dayton, Ohio.

Through research A.O. Smith *. . . a better way*

A.O.Smith

CORPORATION

ELECTRIC MOTOR DIVISION

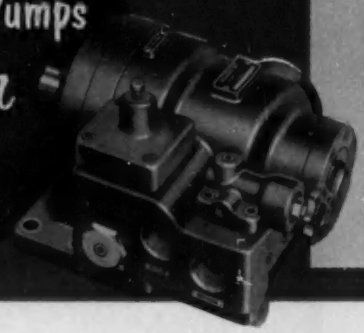
P. O. Box 107 • Dayton, Ohio

International Division: Milwaukee 1, Wisconsin

Do You Want To Save Horsepower and Heat?

VICKERS®

Two-Pressure Oil Hydraulic Pumps Require Less Power for Two-Pressure Circuits



Automatically Provide

High Volume @ Low Pressure for fast closing, rapid advance, and rapid return.

•

Low Volume @ High Pressure for feeding, compressing, clamping, and holding.

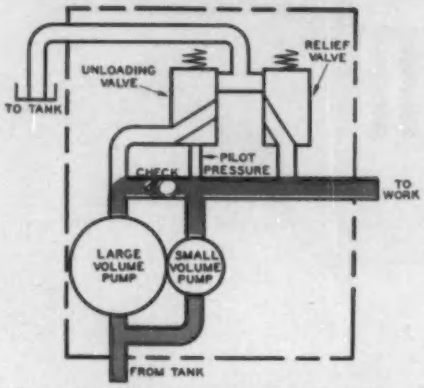


Fig. 1 Combined Delivery of Large and Small Volume Cartridges at Low Pressure

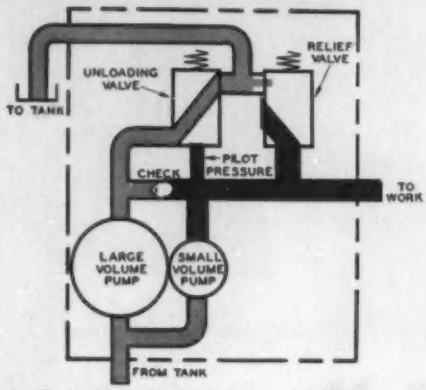


Fig. 2 Delivering Small Volume at High Pressure

Two Vickers Vane Type pumping cartridges are mounted on the same shaft—in the same housing, driven by the same prime mover. One provides a large volume of oil while the other delivers a small volume. These Vickers Two-Pressure Pumps have proved advantageous in a wide variety of applications.

For example, in closing a press or in rapid advance, both pump cartridges work together, supplying maximum volume for quick operation (see Fig. 1). When the press is closed and compression begins, or when the tool goes into feed immediately prior to beginning the cut, the large volume cartridge is automatically unloaded to the reservoir at zero pressure (see Fig. 2). The small volume cartridge alone then provides the lower volume required at high pressure.

These Vickers Two-Pressure Pumps are most economical in power consumption for such two-pressure operation. The reason for this is that a small-volume pump working at full capacity is MORE EFFICIENT than a large-volume pump working at partial capacity. Regardless of momentary delivery, the internal leakage of any pump is proportional to its size and operating pressure. The chart (Fig. 3) shows an interesting comparison between a Vickers Two-Pressure (Two-Volume) Pump and a variable volume vane type pump on a press circuit.

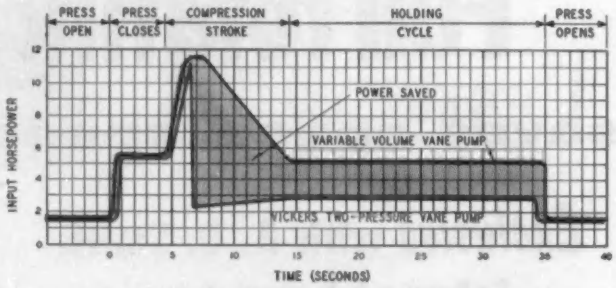


Fig. 3. On this typical press application the saving in power is approximately 50% with a resultant saving in heat in the system.

Like all Vickers Vane Pumps, these two-pressure pumps have the hydraulic balance feature that relieves bearings of all pressure loads (one of the major causes of wear). Cartridge construction enables customer to service in his own plant instead of returning to factory should repairs be necessary. Relief and unloading valves are integral . . . minimizing piping and connections. Complete range of sizes up to 48 gpm. For additional information, ask for Bulletin 54-70a.

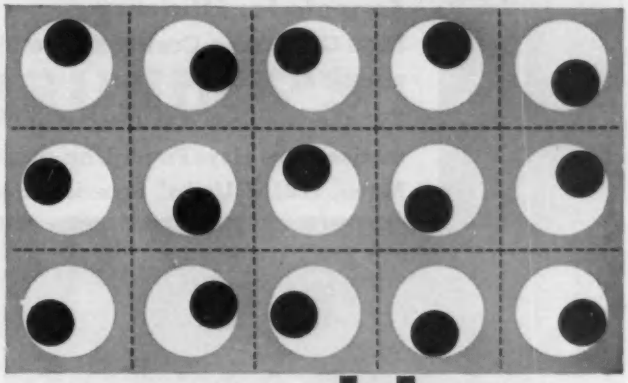
6895

VICKERS Incorporated
DIVISION OF SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: • ATLANTA • CHICAGO AREA (Brookfield) • CINCINNATI • CLEVELAND • DETROIT HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS NEW YORK AREA (Summit, N. J.) • PHILADELPHIA AREA (Media) PITTSBURGH AREA (Mt. Lebanon) • ROCHESTER • ROCKFORD SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA WASHINGTON • WORCESTER

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Illustration indicates infinite variety of positions assumed by screw fastener to compensate for misalignment.



a quick release fastener that...

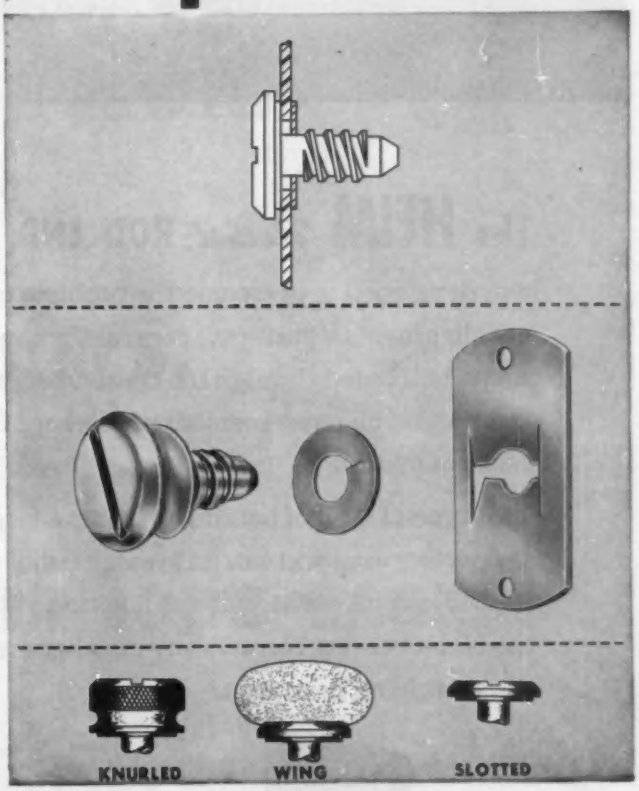
solves alignment problems

"FLOATING SCREW" ASSEMBLY COMPENSATES FOR OUT-OF-LINE DOORS AND PANELS

Installation of access doors and panels is made easy and production is speeded with Southco Quick-Release Fasteners. The wide alignment tolerances of Southco's "Floating Screw" adjust automatically to misalignment, saving mechanics' time. Also, the Southco "Floating Screw" insures accurate and uniform closure throughout the life of the equipment, compensating for warpage and bends resulting from hard usage.

One Southco grip length can meet most panel thicknesses on the average assembly—no need to specify many fastener sizes!

For complete information, write Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.



© 1954

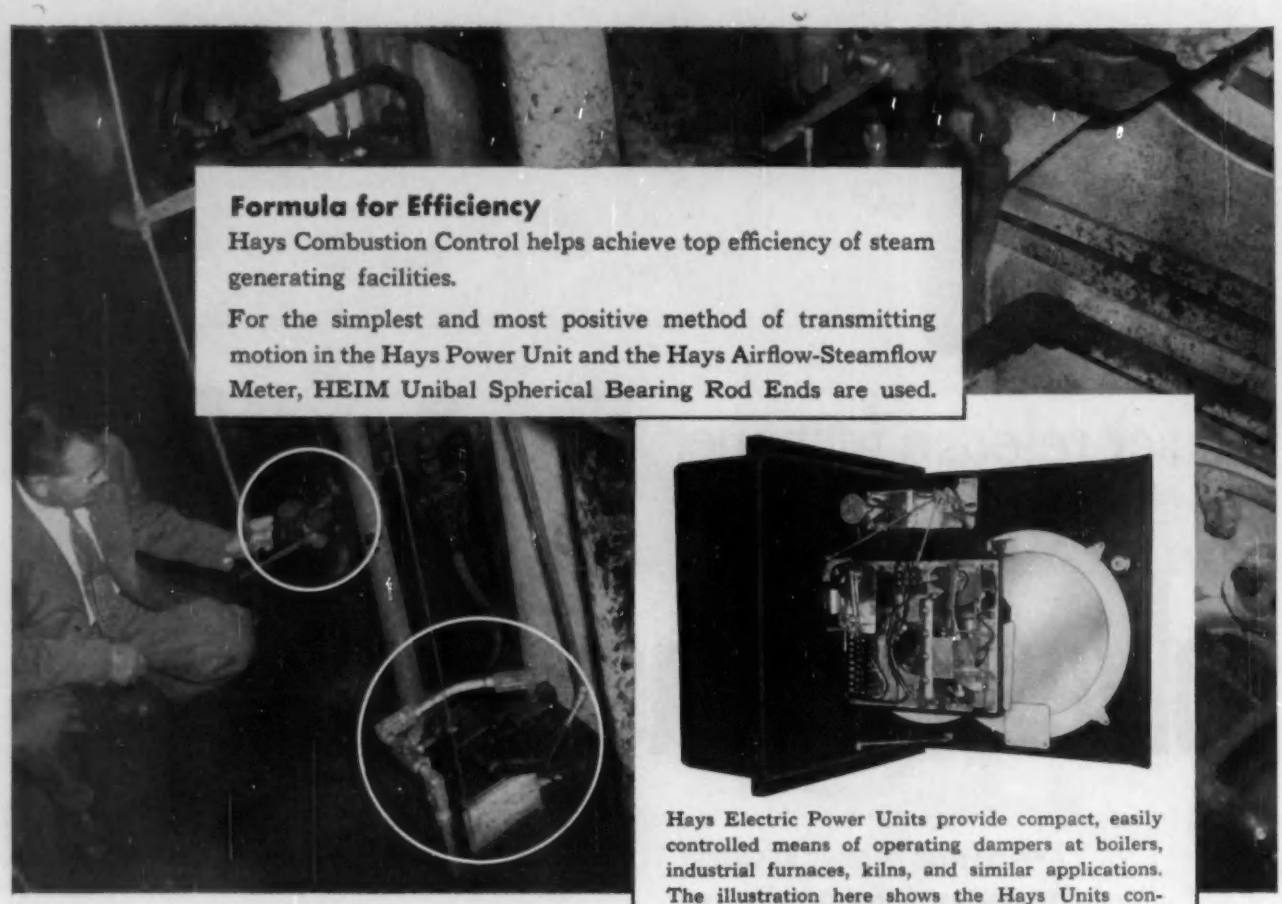
SOUTHCO

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS



Formula for Efficiency

Hays Combustion Control helps achieve top efficiency of steam generating facilities.

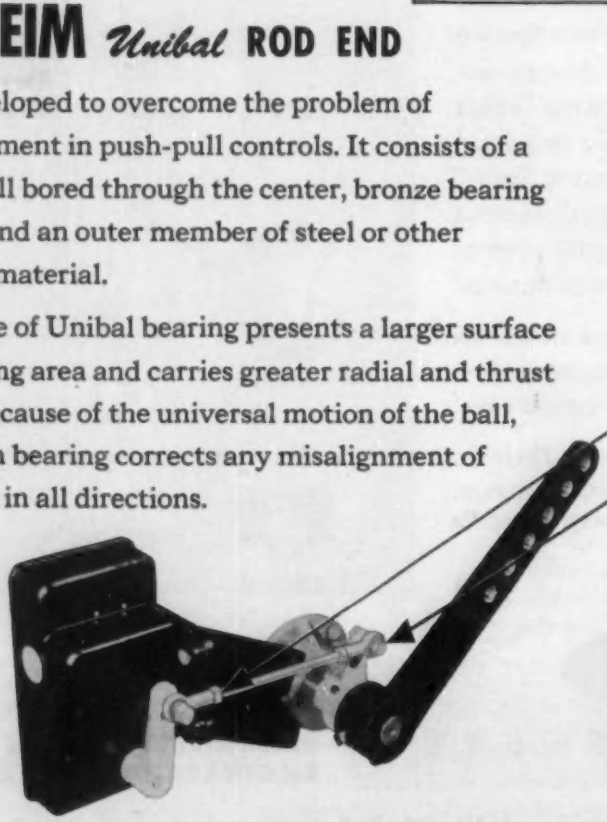
For the simplest and most positive method of transmitting motion in the Hays Power Unit and the Hays Airflow-Steamflow Meter, HEIM Unibal Spherical Bearing Rod Ends are used.

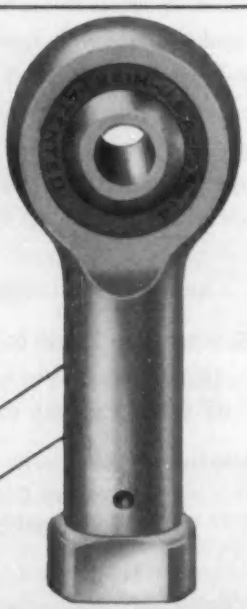
Hays Electric Power Units provide compact, easily controlled means of operating dampers at boilers, industrial furnaces, kilns, and similar applications. The illustration here shows the Hays Units controlling the fuel feed on two Pulverizers.

The HEIM *Unibal* ROD END

was developed to overcome the problem of misalignment in push-pull controls. It consists of a single ball bored through the center, bronze bearing inserts, and an outer member of steel or other suitable material.

This type of Unibal bearing presents a larger surface supporting area and carries greater radial and thrust loads. Because of the universal motion of the ball, the Heim bearing corrects any misalignment of the shaft in all directions.



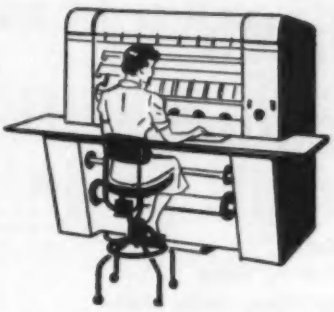


HEIM
ROD END

THE HEIM COMPANY
FAIRFIELD, CONN.

There is a brand new catalog of Heim bearings now ready. Please write for your copy.

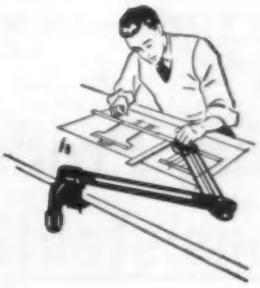
Here's the Inside Story . . .

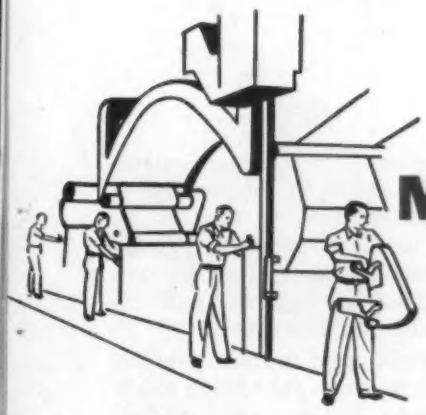


HOW BRUNING'S COMPLETE SERVICE

HELPS ENGINEERS, DRAFTSMEN, AND ARCHITECTS

GET BETTER RESULTS,





MAKE THEIR JOBS EASIER

BRUNING

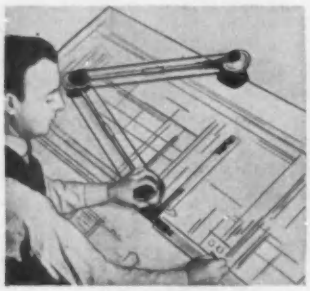
America's Largest Supplier of
Engineering and Drafting Equipment

You Get Better Results Because . . .

Bruning Engineering and Research Bring You New and Better Products

1928—FIRST pencil tracing cloth introduced by Bruning.

1929—FIRST fume-free diazo reproduction machine introduced by Bruning.



1932—FIRST band-type drafting machine introduced by Bruning.

1955—Latest, most advanced whiteprinter introduced by Bruning.

- **First pencil tracing cloths**
- **First non-discoloring tracing paper**
- **First waterproof reproduction tracing cloths**
- **First fume-free diazo reproduction process in America**
- **First band-type drafting machine**
- **First hollow shaft erasing machine**
- **First single-action vacuum frame**
- **First traveling light vacuum frame**

Above are only a few of the many, many products and product improvements which Bruning research and engineering have contributed to the engineering and drafting industry in the past. Today, by virtue of its modern laboratories and large engineering staffs, Bruning still leads the way in the development of new and better products for you. Within the past year, for instance, Bruning introduced newly improved tracing papers and cloths that set a new standard in their field . . . newly improved sensitized materials that give you quality reproduction never before attainable . . . new, improved Copyflex machines that set at a new high in quality, convenience, and economy of reproduction. You can depend on Bruning for more of the same in the future.

Bruning Production Brings You Products of Consistently High Quality

A manufacturer as well as supplier, Bruning controls quality all the way to make sure you get products of dependable, consistent high quality.

Bruning tracing papers, noted for their high translucency, fine drawing surfaces, and permanence, are Bruning-controlled, step by step, from the mill . . . through processing . . . to the ultimate user.

Bruning exercises the same rigid control, uses the most modern equipment in its paper converting plants at Teterboro, N. J., Chicago, Kansas City, and Los Angeles, to provide you with 85 varieties of the finest sensitized papers, cloths, and films.

And the famous Copyflex reproduction machines are manufactured in Bruning's own large, modern Chicago plant — quality-controlled from raw material to final assembly to provide you the finest in reproduction performance.

You Get Better Results at Lower Cost, Your Job is Made Easier Because . . .

Bruning Brings You a Complete Line of Highest Quality Products

- ***Assures Efficient Integration of Companion Products***
- ***Simplifies Ordering and Stocking***

You, like draftsmen, engineers, and architects everywhere, can profit by using Bruning as your *Single, Convenient, Dependable Source* for everything you need in top-quality drafting room supplies. There is a Bruning product to suit every need, fit every budget. You simplify ordering and stocking, save time and money. Companion products, like Copyflex reproduction machines and Copyflex sensitized materials, are made to work together to give you premium results.

COPYFLEX REPRODUCTION MACHINES

Copyflex offers all the benefits of diazo black-on-white reproduction — speed, economy, quality prints—plus problem-free installation and operation. No fumes, no exhaust ducts. There's a model to meet every need.

COPYFLEX SENSITIZED MATERIALS

Bruning offers an unrivalled selection of sensitized papers, cloths, and films, available in a variety of sizes and weights, in sheet or roll form. Papers come in white and five tints.

BRUNING DRAFTING EQUIPMENT AND SUPPLIES

Bruning's wide selection includes not only standard items, but such special aids as dotting pens, proportionate dividers, planimeters and Wrico lettering sets.

BRUNING TRACING PAPERS AND CLOTHS

These new, improved drawing mediums set a new high standard in translucency, pencil-and-ink-taking qualities, and permanence. Choose from a complete variety.

BRUNING DRAFTING MACHINES

Choose from a range of models and prices. Patented "Equipoise" gravity compensator, exclusive Touch Control Indexing provide unrivalled simplicity, precision, and ease of operation.

BRUNING ERASING MACHINES

These easy-to-use machines do a better job of erasing, save time. An extra-long, seven-inch eraser prevents "fly-out." They are quiet, cool, vibration-free tools ideal for all departments.

DRAFTING ROOM FURNITURE

Everything for the drafting room, in a range of materials and styles to meet every price requirement—including famous Hamilton Auto-Shift drafting tables and Unit-System files.

SURVEYING EQUIPMENT

This complete line features famous Brunson precision surveying instruments with exclusive dust-proof ball bearing construction for lasting accuracy, minimum maintenance, ease of operation.

You Get Better Results at Lower Cost, Your Job is Made Easier Because....

CHICAGO PLANT

KANSAS CITY PLANT

TETERBORO, N. J., PLANT

LOS ANGELES PLANT

▲ 19 BRUNING SALES-SERVICE BRANCHES ● 6 BRUNING DISTRIBUTORS
Ⓐ 4 STRATEGICALLY LOCATED PLANTS

Bruning's Service and Supply is Right in Your Own Backyard!

With the most comprehensive network of sales-service branches, distributors, and plants in its field, Bruning assures you of prompt, dependable service and supply.

No Lost Time for Lack of Service!

Your nearby Bruning branch is headquarters for a capable staff of Bruning sales-service specialists. Your Bruning representative, with valuable experience gained in serving the engineering and drafting profession, is always available to you. He is close at hand to give you the help you need when you need it, whether it concerns machine servicing, product application, or any problem relative to the operation or development of your engineering, drafting, or reproduction department.

No Costly Delays for Lack of Supply!

You get the Bruning product or material you need when you need it! The strategically located Bruning branches and distributors carry a full line of Bruning products, are staffed and equipped to give you fast, efficient supply. You run no risk of costly delays for lack of products or materials.

BRUNING

There you have it—the "big package" from Bruning for you! You get a complete line of high quality products! You get better service! They work together to bring you better results and to make your job easier.

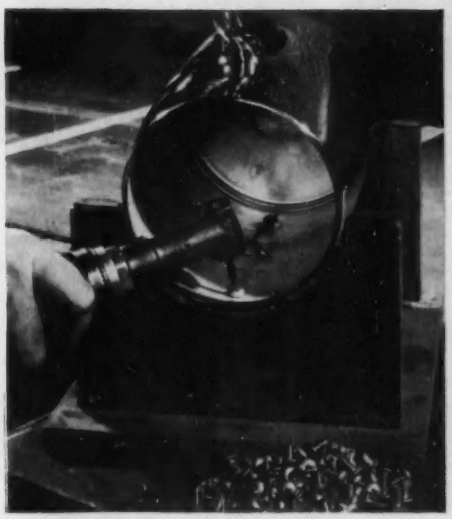
CHARLES BRUNING COMPANY, INCORPORATED • 4700 MONTROSE AVENUE, CHICAGO 41, ILLINOIS

A-2195

Printed in U.S.A.

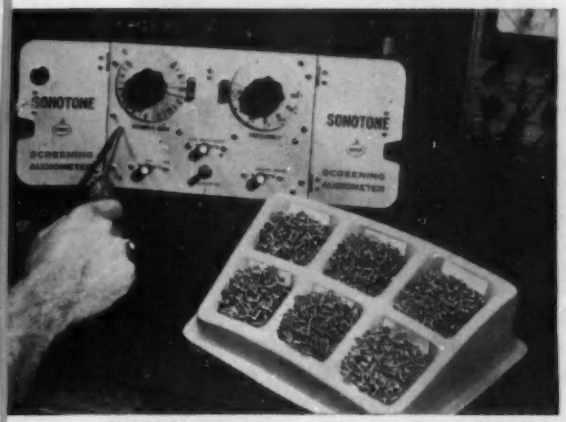
NEW SOLUTIONS TO ASSEMBLY PROBLEMS

Many manufacturers in many fields are finding Phillips Cross-Recessed-Head Screws lead to better methods and results



IN "BLIND" LOCATIONS. A product engineer of Dominion Electric Corporation reports, "Phillips screws permit us to design appliances in which screws can be inserted in 'blind' locations. Also they definitely speed our production and improve product appearance."

MINIMUM REJECTS. In The Wiremold Company's "Plugmold", Phillips screws assure a tighter assembly and more positive electrical contact. "Besides being neater and easier to use," says the Wiremold plant engineer, "Phillips screws have reduced our rejects to a negligible amount. Under no conditions would we use any other type screw."



MARRING ENDED. In assembling the dial panels on Sonotone Audiometers, Phillips screws are used exclusively. A Sonotone official gives one of the reasons why: "A slip of a screwdriver would mar or scratch the panels' anodized surface, automatically causing rejection. Phillips screws don't slip."

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY... AND OF THE FUTURE

X marks the spot

the mark of extra quality

Allmetal Screw Products Company, Inc. • American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company • Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Company Rockford Screw Products Company • Scovill Manufacturing Company • Shakeproof Division Illinois Tool Works • The Southington Hardware Manufacturing Company Sterling Bolt Company • Universal Screw Company • Wales-Beech Corporation

Heavy tooth loads require gears of Nickel Alloyed Steel

For high compression strength and wear resistance

THE GEARS BELOW actuate movements of a giant, high-speed earthmover.

When the machine scrapes up a 23 cubic yard bite of earth to haul away at almost 30 miles per hour, the gears often carry extremely heavy loads.

But any reasonable set of demands can be met by use of nickel alloyed steels . . .

For Example

Where you need maximum wear resistance in the surface, plus all the surface compressive strength you can get, use a nickel alloy *carburizing* steel.

These steels provide extremely tough cores that resist shock loads, fatigue and bending stresses. In addition, they minimize the distortion in heat treatment which is a major cause of noisy gears.

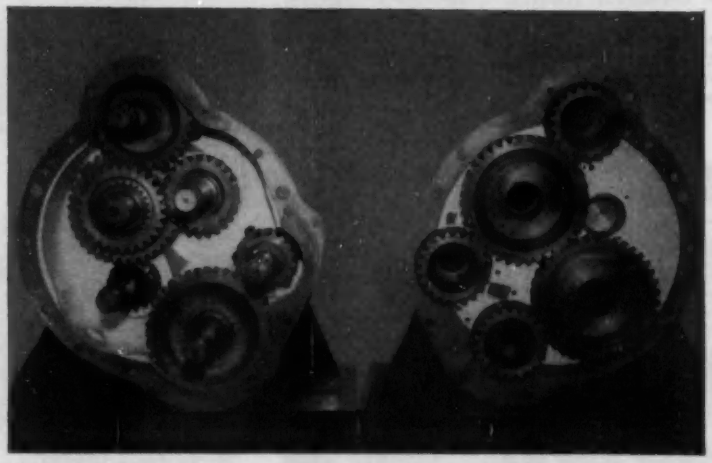
Where tooth loading is heavy, but surface compressive stresses and wear are not extreme, use a *direct hardened* nickel alloyed steel. It will give you the needed strength more consistently and in heavier sections than carbon grades.

Generally, steels containing nickel offer high resistance to shock, fatigue and multi-axial stresses. Moreover, you can readily machine nickel alloy steels before final heat treatment.

Booklet gives complete story

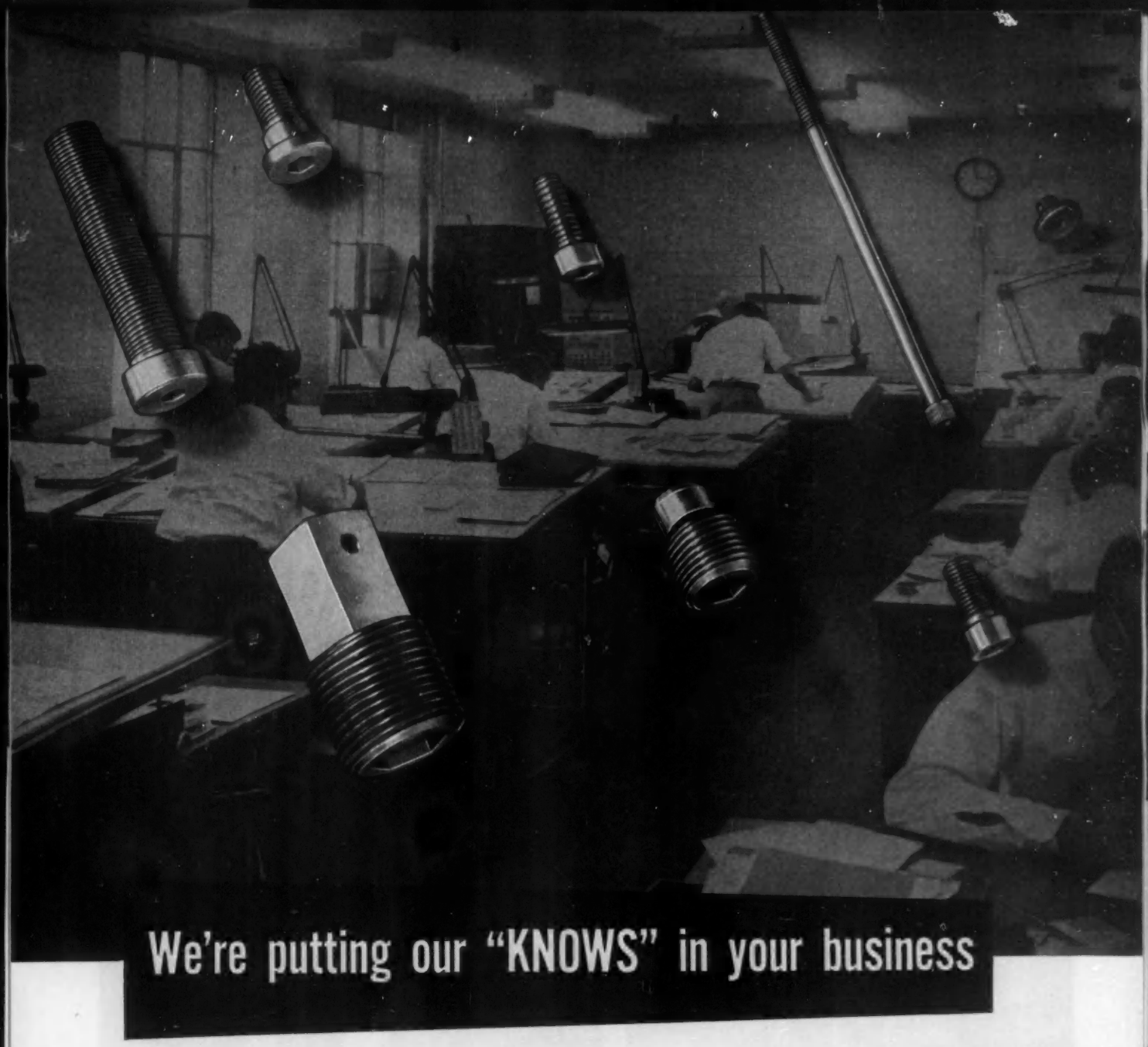
Meet the demand for gears that permit high speeds and heavy loads. For gears that run smooth . . . last long. Every engineer and designer should have a copy of "Modern Trends in Nickel Steel and Cast Iron Gear Materials." This illustrated booklet contains a wealth of information and data. It may be exactly what you want. It's yours for the asking. Write for your copy now.

INCO TRADE MARK



Gears and Pinions of nickel alloyed steel stand the gaff in earth-moving equipment produced by Le Tourneau-Westinghouse Co., Peoria, Ill. The grades of steel used include 3310-H and 4820-H for severe duty, 4320-H for medium heavy service and 8620-H for relatively lighter tooth loads.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N.Y.



We're putting our "KNOWS" in your business

Allen engineers solve a problem a day... for socket screw users

Allen has always been headquarters for socket screw know-how. Last year, Allen metallurgists, designers and engineers teamed up to handle over 360 technical problems for precision fastener users.

Most of these problems were quickly answered over the phone... many required a trouble shooting engineering team to consult with the manufacturer, analyze his problem and design special products for his use...some were even concerned with our competitor's products. But each problem, no matter how simple or complex, was solved to the manufacturer's satisfaction.

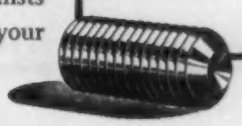
When you've got a question on socket screws, let our engineers help you. They're socket screw specialists ready to put their "knows" in your design problems.

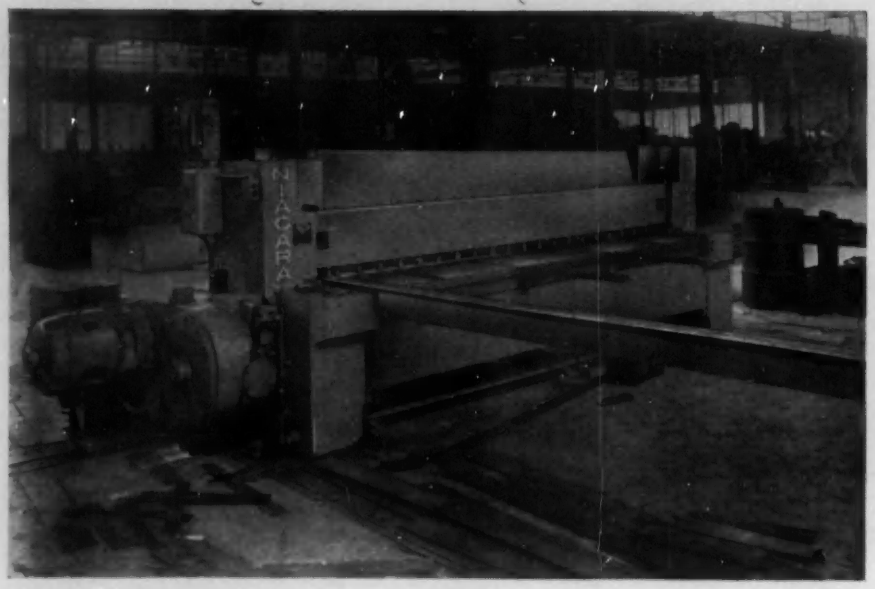
When ordering through your local Industrial Distributor, specify genuine Allen Socket Screws

ALLEN

MANUFACTURING COMPANY

Hartford 2, Connecticut





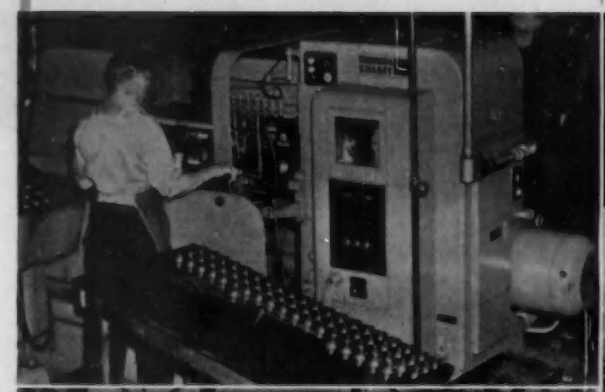
Century Performance-Rated Motor provides heavy duty muscle power for this large shear.

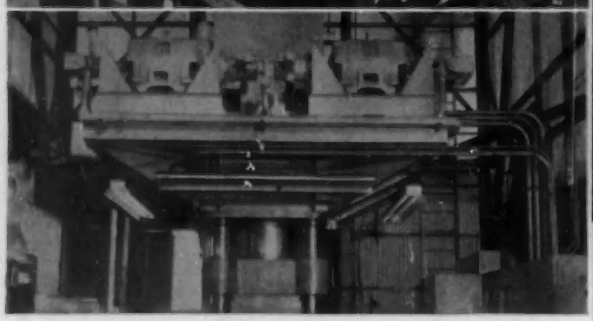
The ability to handle heavy shock load was an important factor in the selection of a Century Motor with proper torque and speed for this application.

Century Performance-Rated® Motors for

Century Performance-Rated Motor helps get production out fast on 5-spindle automatic chucking machine.

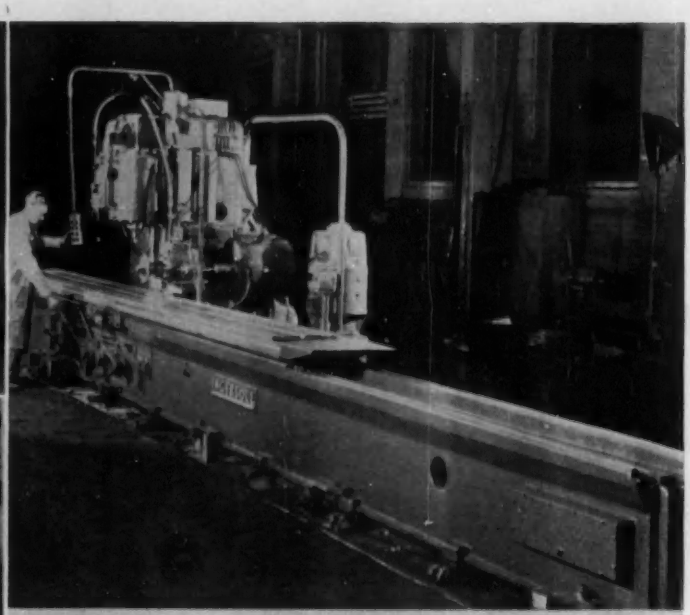
In the selection of a Century Motor, all the factors were Performance-Rated to match the specific application—speed, torques, mounting and frame protection.





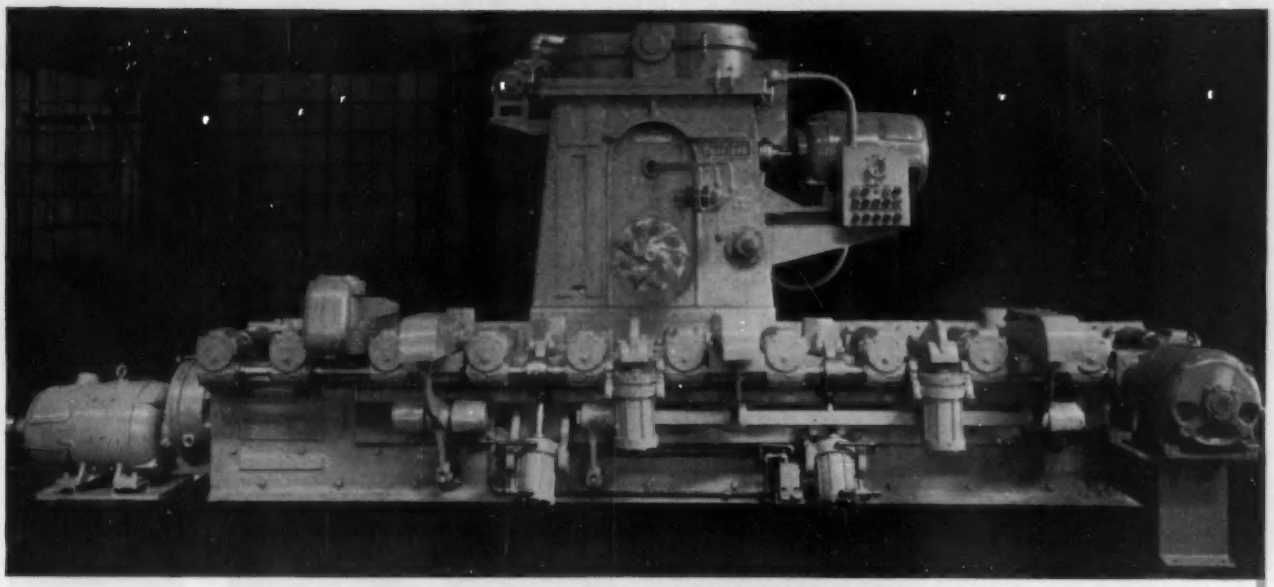
5 Century Performance-Rated Motors help produce 5,000,000 pounds of controlled pressure.

Each of the five 100 H.P. Century Motors possesses the proper torques and speed to help this giant press operate profitably.



5 Century Performance-Rated Motors help bring out the best performance from this 22-ft. keyway slotter.

With each motor engineered for top performance in its own specific job, the 5-motor Century team contributes to cost-saving operation of this important unit.



15 Century Performance-Rated Motors are the power team for fast skinning of high-chrome steel billets.

These *Performance-Rated* Century Motors provide ample power for skinning "52100" high-chrome steel billets at a rate of 2900 sq. in. per hour.

Modern Ideas

IN PRODUCTION MACHINES

Leading designers will tell you that much of the precision and efficiency of modern machine tools depends on motors properly "fitted" to the job. In many cases, these are Century Motors. Because they are Performance-Rated, Century Motors provide an unequalled wide range of speed, torque, mounting and frame characteristics. When properly selected, they bring out the best performance in any machine.

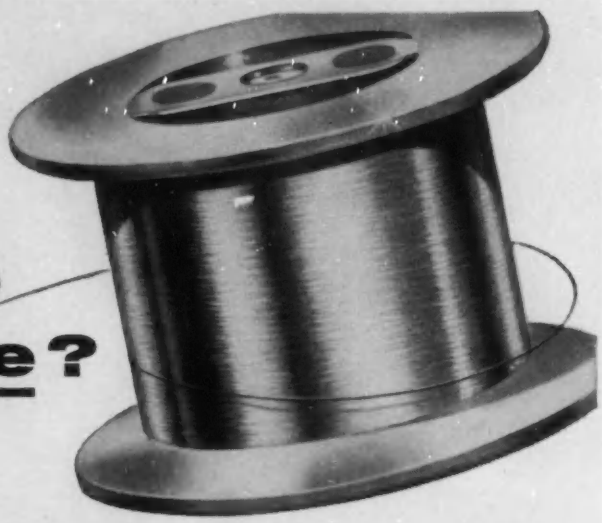
Get full value from your investment in new equipment . . . specify Century Motors! For Performance-Rated replacement motors, call your nearby Century authorized distributor or contact our District Sales Office.

®Performance-Rated MOTORS 1/8 to 400 H. P.

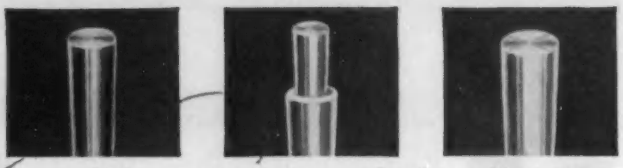
CENTURY ELECTRIC COMPANY

1806 Pine Street • St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

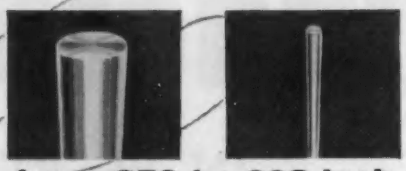
is there a Special way you want to use cold-drawn Wire?



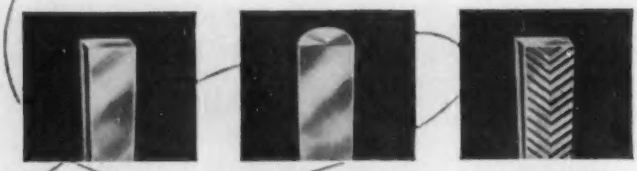
. . . if it calls for a special material



. . . in a special size



. . . or a special shape



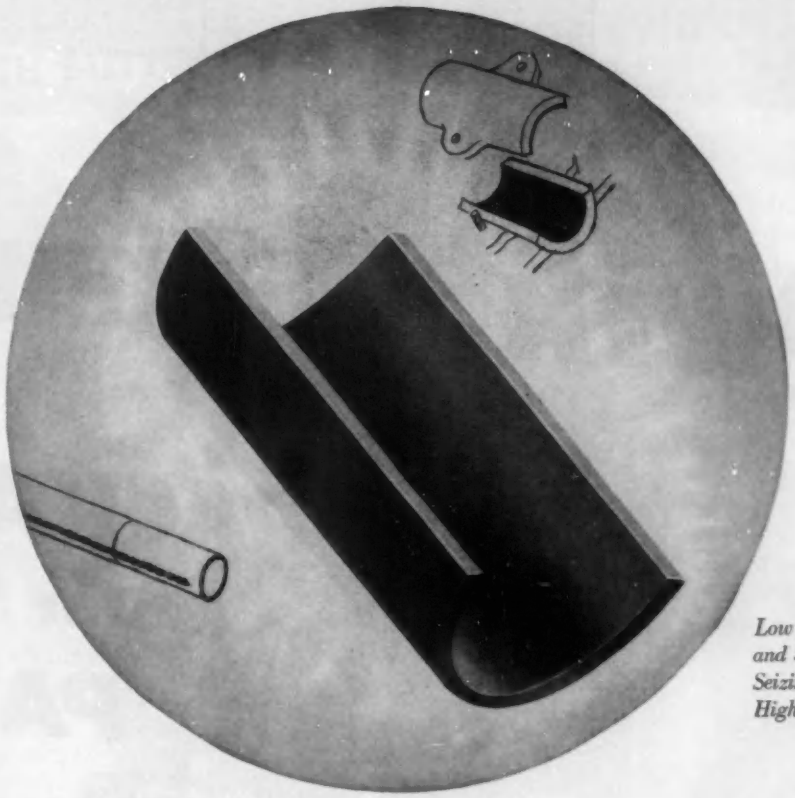
SYLVANIA IS EQUIPPED to fill your most exacting electrical and mechanical requirements.

For the complete story of Sylvania's advanced wire production and quality-testing methods, write for this new, illustrated booklet. While you're at it, tell us about your special wire needs. Write Dept. E33S.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine Street, Montreal, P.Q.

LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY



Low Friction Bushings and Sleeves Resist Seizing, Abrasion, High Temperatures

HAYNES STELLITE Bushings and Sleeves

Trade-Mark

...for handling Hot-Abrasive Materials

Bearing parts made of HAYNES STELLITE alloy resist seizing and galling. They are hard and abrasion resistant, and will withstand the pitting effects of many corrosives. They take a high polish and are easy to apply. Use them to reclaim worn shafts or bearing blocks, and to lengthen the life of new equipment.

Operate with Little or No Lubrication

Sleeves made of HAYNES STELLITE alloy can be used in areas where efficient lubrication is impossible. They resist seizing even when lubricants are diluted by gasoline, cleaning fluids, and other liquids that wash out an oil film. They operate at peak efficiency even when lubricants decompose under heat, or are destroyed by abrasive particles.

Tough and Abrasion-Resistant

Bearing parts made of HAYNES STELLITE alloy resist the abrasive effects of wet or dry materials such as fly ash, coke, metal powder, shale, and cement dust. They are hard enough to carry heavy loads, and tough enough to stand up under repeated stress.

Heat and Corrosion Resistant

These bushings and sleeves can be submerged in many acids, alkalies, and molten metals. Temperatures as high as 1500 deg. F. have little effect on their hardness, toughness, and dimensional stability.

For more information write for our 8 page booklet on half bushings and sleeves.

"Haynes" and "Haynes Stellite" are registered trade-marks of Union Carbide and Carbon Corporation.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

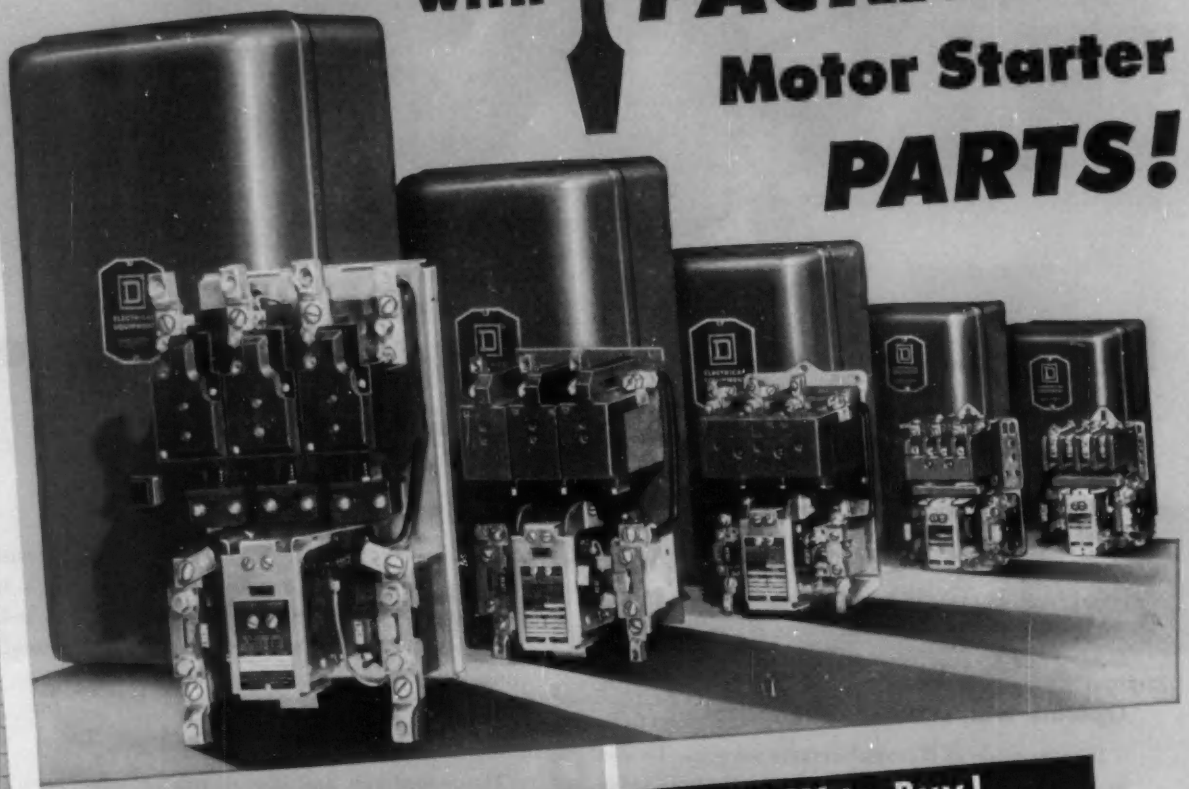
General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago · Cleveland · Detroit · Houston · Los Angeles · New York · San Francisco · Tulsa

Qwik Change

with **PACKAGED Motor Starter PARTS!**



EASY to Identify!

Easy-to-read catalogs, simplified motor control and overload relay selectors, illustrated service bulletins...these all combine to assure *quick changes* through easy parts identification.

EASY to Buy!

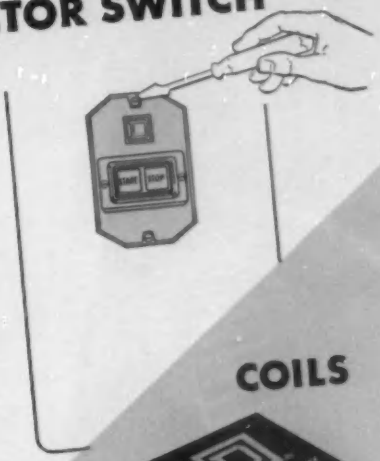
Conveniently packaged and labeled conversion parts are immediately available "off-the-shelf" from a nationwide network of authorized Square D electrical distributors.

Write for Bulletin 9999. Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin.

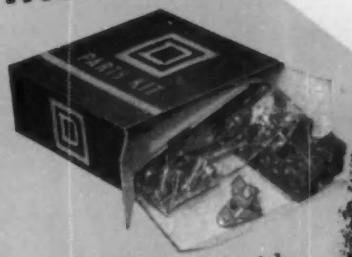
SQUARE D COMPANY

NEW PUSH BUTTONS AND SELECTOR SWITCH

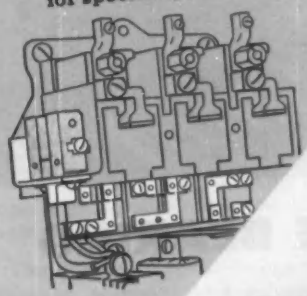
These Kits contain all parts necessary to make quick changes from standard starters to either push button or selector switch controlled devices.



INTERLOCKS

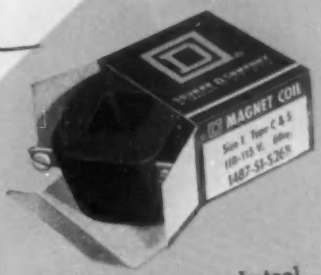


A wide variety of quick-change, front-mounted interlocks adds flexibility for special applications.

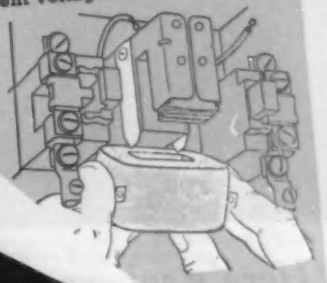


Faster to Install

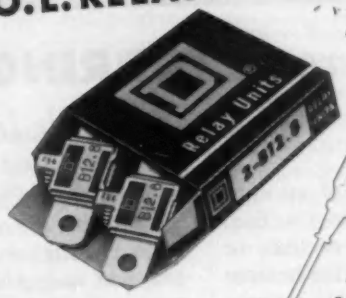
COILS

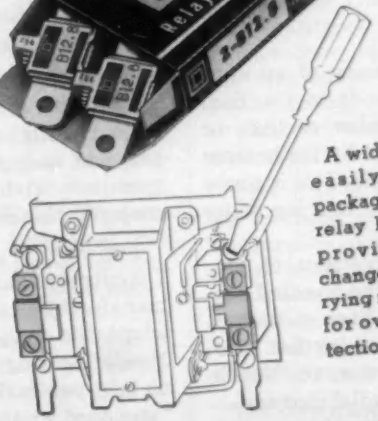


Screwdriver is only tool required for quick change of magnet coil to accommodate different voltages.



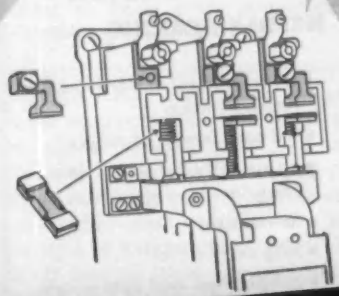
O.L. RELAYS





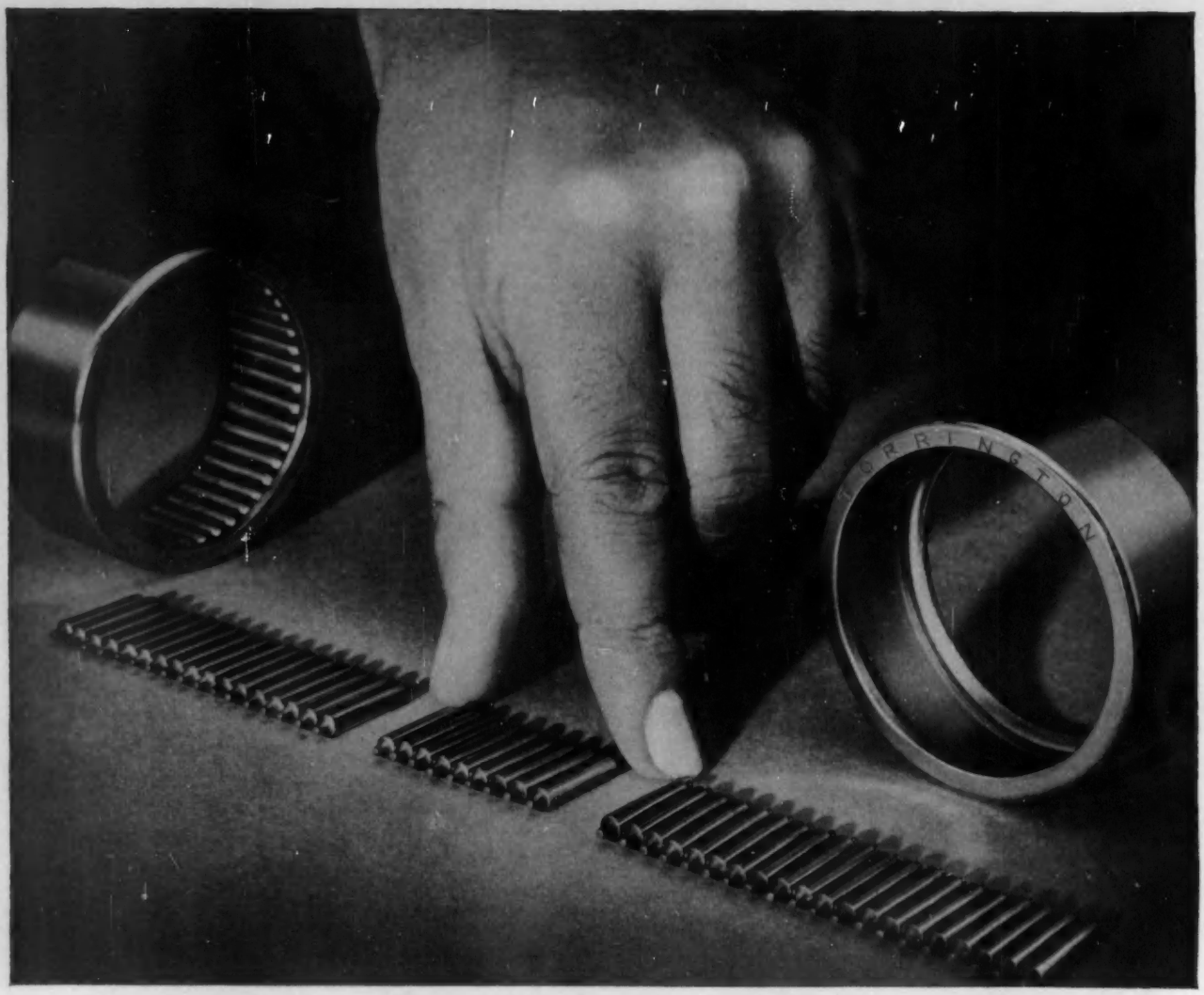
A wide variety of easily selected, packaged overload relay heater units provides quick changes to meet varying requirements for overload protection.

CONTACTS



Packaged replacement contacts are easily installed without disturbing wiring.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS



"Here's where the **TORRINGTON NEEDLE BEARING** *gets its high load capacity"*

The radial load capacity of an anti-friction bearing depends, in the final analysis, on the number of lines or points of contact made by the bearing surfaces in the load zone. This is where the Torrington Needle Bearing really shines.

With its full complement of precision-ground rollers, the Needle Bearing gives many more lines of contact than other types of anti-friction bearings. Thus for a given size, the Needle Bearing has a *greater* radial load capacity than other bearings.

What does this do for your product? The Needle Bearing can give you the benefits of its high-capacity performance for little more than the cost of a plain bearing; it can help you reduce the size and weight of surrounding members without sacrificing shaft strength, thickness or rigidity.

For twenty years, our Engineering Department has helped designers and manufacturers throughout industry to adapt the unique advantages of the Needle Bearing to their products. Let us help you make the Needle Bearing "standard equipment" in yours.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* **BEARINGS**

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

These features make the **TORRINGTON NEEDLE BEARING** *unique*

- low coefficient of starting and running friction
- full complement of rollers
- unequalled radial load capacity
- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits use of larger and stiffer shafts

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co.

Reporting new developments in copper-base alloys and metalworking methods.

Bridgeport High I. Q. Brass gives rich gold color, high gloss finish to stylish vanity and lipstick cases. (Courtesy, Zell Products Corp., Norwalk, Conn.)

Beauty in Brass:
A Story of the 4th Dimension

"Rich as gold," describes the deep warm color of Bridgeport 87 Brass. And, "polished as a mirror," describes the lustrous finish Zell Products Corp., Norwalk, Conn., gives to its line of vanity and lipstick cases. The success of this story belongs to the High I. Q. (Inner Quality) of Bridgeport brass strip, and the 4th Dimension, its optimum grain size.

The cases are made primarily by blanking, stamping and cupping thin strips of brass (Alloy 87); 87% copper, 13% zinc. Therefore, a certain amount of ductility is essential in the metal. The mirror-smooth polish is brought out by buffing, which calls for a fine grain size. The combination of these two qualities is a finely-balanced compromise to bring both properties to ideal working requirements.

Bridgeport supplies this exceptionally smooth metal, tailored to the customer's requirements—⅛th hard and light anneal temper, with .015 mm grain size. Metal of this temper provides an extremely smooth surface after forming which may be buffed to a high gloss with a minimum of labor and time. It has an ideal combination of ductility and ability to take a high polish for a great many profitable applications.

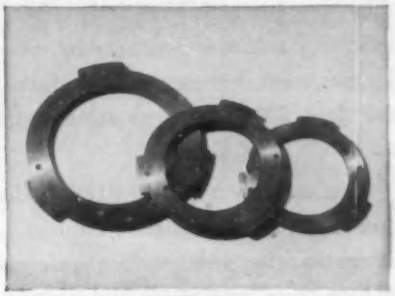
Many other combinations are also available, each suited to a particular range of forming and buffing requirements. So ask your Bridgeport Technical Service representative to assist in your metal selection. Make sure of the 4th Dimension—the right grain size to meet both product needs and production methods, for no one fine-grain brass does all jobs well.

Bridgeport Phosphor Bronze Makes Tough, Long-Wearing Clutch Plates

Since 1929, the Rockford Clutch Division of Borg-Warner Corp., Rockford, Ill., has used Bridgeport Phosphor Bronze Grade A (Alloy 36) for clutch outer discs in their Pullmore Multiple-Disc Clutches. They have used this alloy consistently because of its outstanding strength and superior resistance to wear under severe operating conditions, another example of properties assured by the High I. Q. (Inner Quality) of Bridgeport alloys.

The alloy is supplied by Bridgeport in strip form, rolled to an extra spring temper of 9 B&S numbers hard, and having correct surface finish to meet specifications. Automatic machines stamp blank discs, 1¾ in. to 10⅞ in. in diameter, from three thicknesses of strip; .062 in., .092 in. and .125 in. Each is then pierced with a large hole for the clutch shaft and with a series of small holes around the working periphery of the clutch disc. They are then flattened, heat treated to 500°F. The small holes are impregnated with graphite to complete the part.

The clutches in which these discs perform are used on main drives, auxiliary controls, and power take-off mechanism to obtain forward and reverse movements, or high and low speeds. They serve as both clutch and brake, and therefore must be rugged.



Clutch discs of Bridgeport High I. Q. Phosphor Bronze have high strength and wear resistance in heavy-duty service. (Courtesy Rockford Clutch Division, Borg-Warner Corp.)

Composed of approximately 95% copper and 5% tin, Bridgeport Phosphor Bronze Grade A (Alloy 36) has high resistance to fatigue and wear from rubbing against other materials, excellent spring properties under repeated flexing, and greater resistance to corrosive attack than most brasses and copper.

This alloy is also recommended for use in metal bellows for temperature and pressure control instruments, clutch discs, bridge bearing plates, screens and beater bars in many of the process industries; snap switches, spring contacts and other parts for electrical and electronic equipment.

For even more severe service, Bridgeport Phosphor Bronze Grade C (Alloy 35), composed of 92% copper and 8% tin, would be the preferred alloy. High I. Q. metals are produced with Inner Qualities to meet the most rigorous specifications of the industry. (3138)

Bridgeport Brass Co.

BRIDGEPORT BRASS COMPANY ♦ BRIDGEPORT, CONNECTICUT

Mills at Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich. Sales Offices in Principal Cities—Conveniently Located Warehouses

THE *NEW* 100 SERIES REDUCTORS

BOSTON Gear®

again sets the standard for cost-wise speed conversion

The New 100 SERIES is designed for peak efficiency and new economy by industry's largest, most experienced manufacturer of standard STOCK speed reduction units . . . BOSTON Gear.

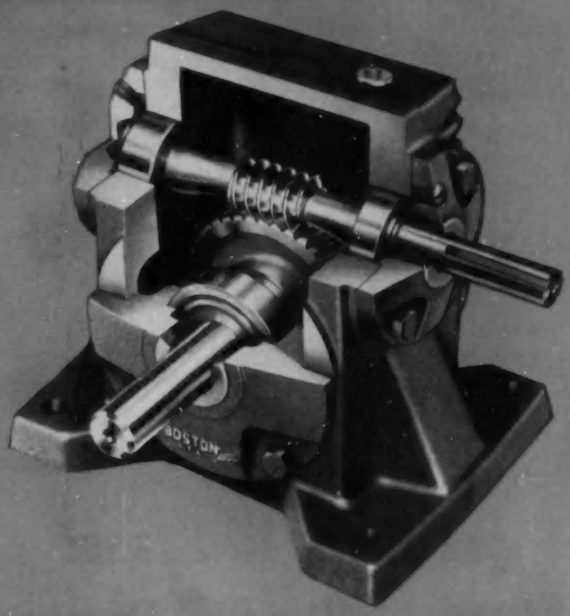
You can select 100 SERIES Reductors and Ratiomotors with complete confidence that they will improve performance, reduce costs, save space and weight, and simplify your job of product design.

Listed output of 100 SERIES units is *certified* by BOSTON Gear to be actual torque delivered, as determined in *Independent Laboratory* tests. Design around the 100 SERIES. Give your product the extra value of speed reduction units that deliver

Certified

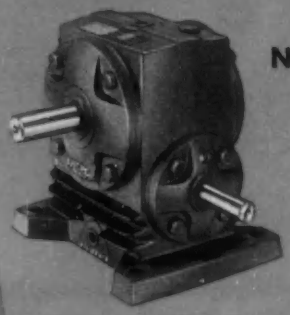
MAXIMUM HORSEPOWER PER DOLLAR

by actual test!



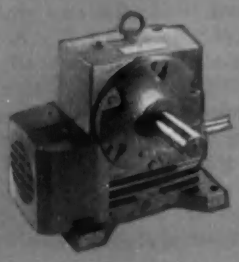
NEW **COMPACT DESIGN, less space and weight**

NEW "clean" contours
NEW cooling fins on housings
NEW gearing efficiency
NEW range of applications
NEW maintenance savings
BOSTON GEAR quality



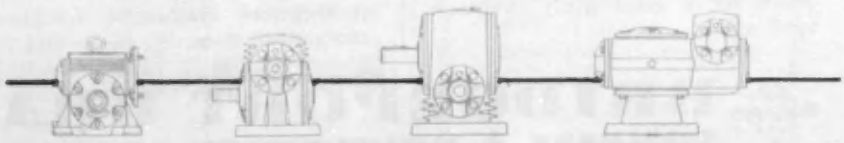
FAN COOLING

Optional in larger sizes, to provide maximum air circulation resulting in greater torque capacity.



108 MODELS—671 DIFFERENT UNITS—FROM STOCK—

TO MEET ANY MODERN DRIVE NEED

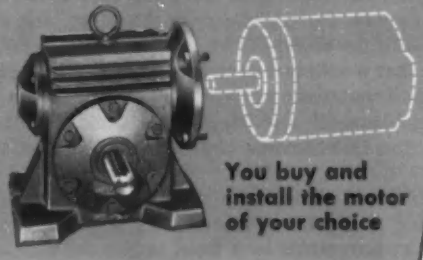


100 SERIES

RATIOMOTORS

RATIOMOTORS
— the complete power package

FLANGED REDUCTORS
— Ratiomotors less motors



You buy and install the motor of your choice

NEW *Combination* DESIGN

Simplified construction combines independent reduction gear unit with easily detachable, standard end-mounted motor for easy maintenance. Permits . . .

1 Replacement of motor without disturbing reduction gear unit.

2 Replacement of original motor at any time with motor of special characteristics (totally enclosed, explosion-proof, etc.)

FLANGED REDUCTORS are the reduction gear units of Ratiomotors supplied to you without motor. You buy and attach any end-mounted motor you choose. Flanged Reductors are made in the same range of models and ratings as Ratiomotors.

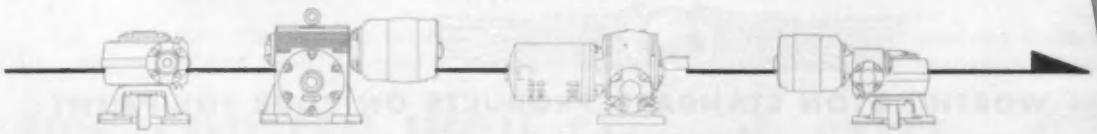
GET NEW CATALOG R-56. Gives complete specifications of all models, selection charts, engineering data. Ask your BOSTON Gear Distributor, or write: . . . Boston Gear Works,
71 Hayward St., Quincy 71, Mass.

Call your

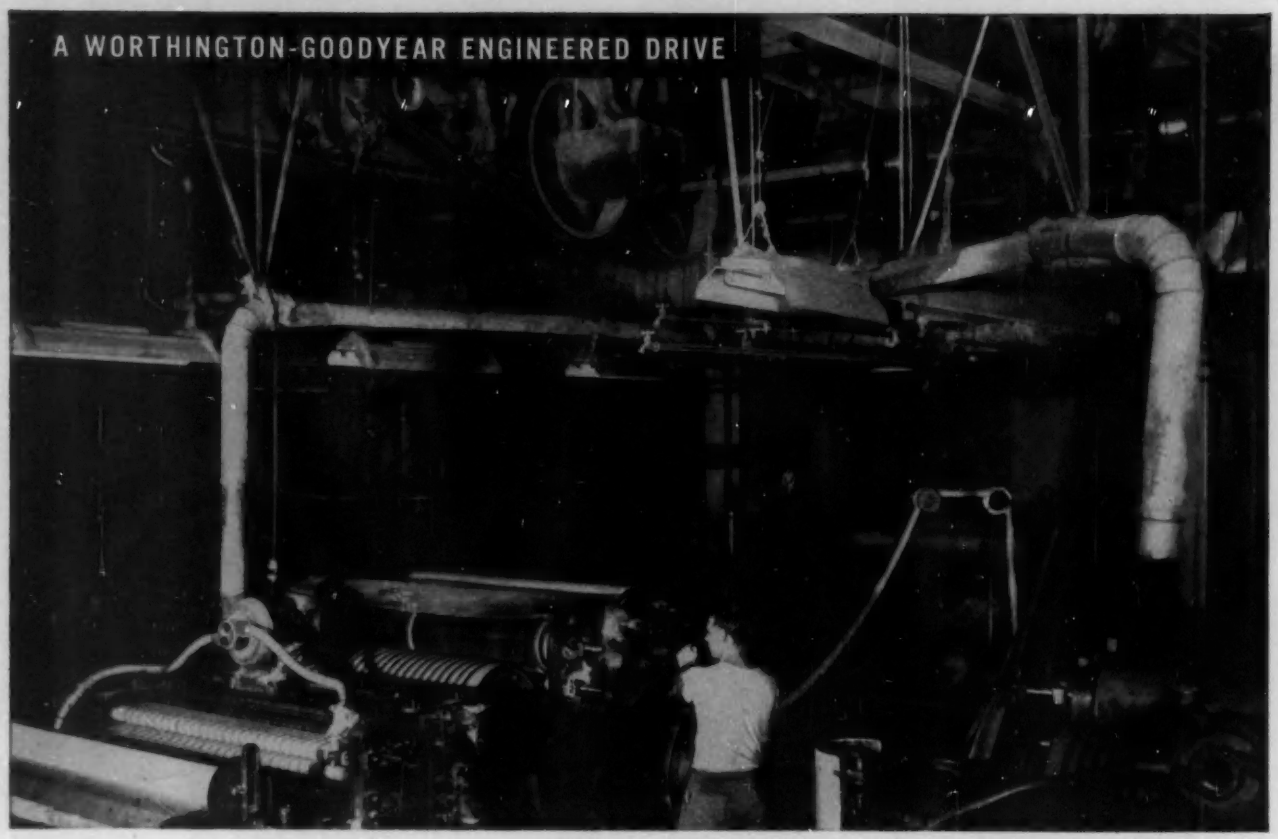
BOSTON Gear®

DISTRIBUTOR

Look under "GEARS" in the Yellow Classified Section of your Telephone Directory for the BOSTON Gear Distributor nearest you.



55BG-R-11



SMOOTH, NON-SLIP DRIVE is a must for these card machines of the Hardwick & Magee Company. Worthington Multi-V-Drive (overhead) does the job.

High torque without slippage or stretch

Worthington distributor solves unusual overhead drive problem

FOUR YEARS OF TROUBLE-FREE OPERATION. That's what Hardwick & Magee like about their efficient Worthington Multi-V-Drive.

How to get a drive that would withstand high torque without slipping? That was the problem faced by the Hardwick & Magee Company, Philadelphia manufacturers of carpets and rugs.

Hardwick & Magee Company needed a dual drive for their cards, made up of a drive from the motor to a jack shaft, and a drive from the jack shaft to a line shaft. The problem was with the second drive, which had fixed centers and consequently needed a drive that would not stretch and require take up.

After consulting Industrial Transmission Machinery, Worthington distributors in the Philadelphia area, Hardwick and Magee Co., decided that this was definitely a job for Worthington QD Sheaves and Goodyear Steel Cable belts because:

1. The tapered, split QD hub would allow no pulley slippage on the shafts, and
2. The Goodyear Steel Cable V-Belts would carry the high load with NO stretch, thereby fulfilling the requirements of a fixed center drive.

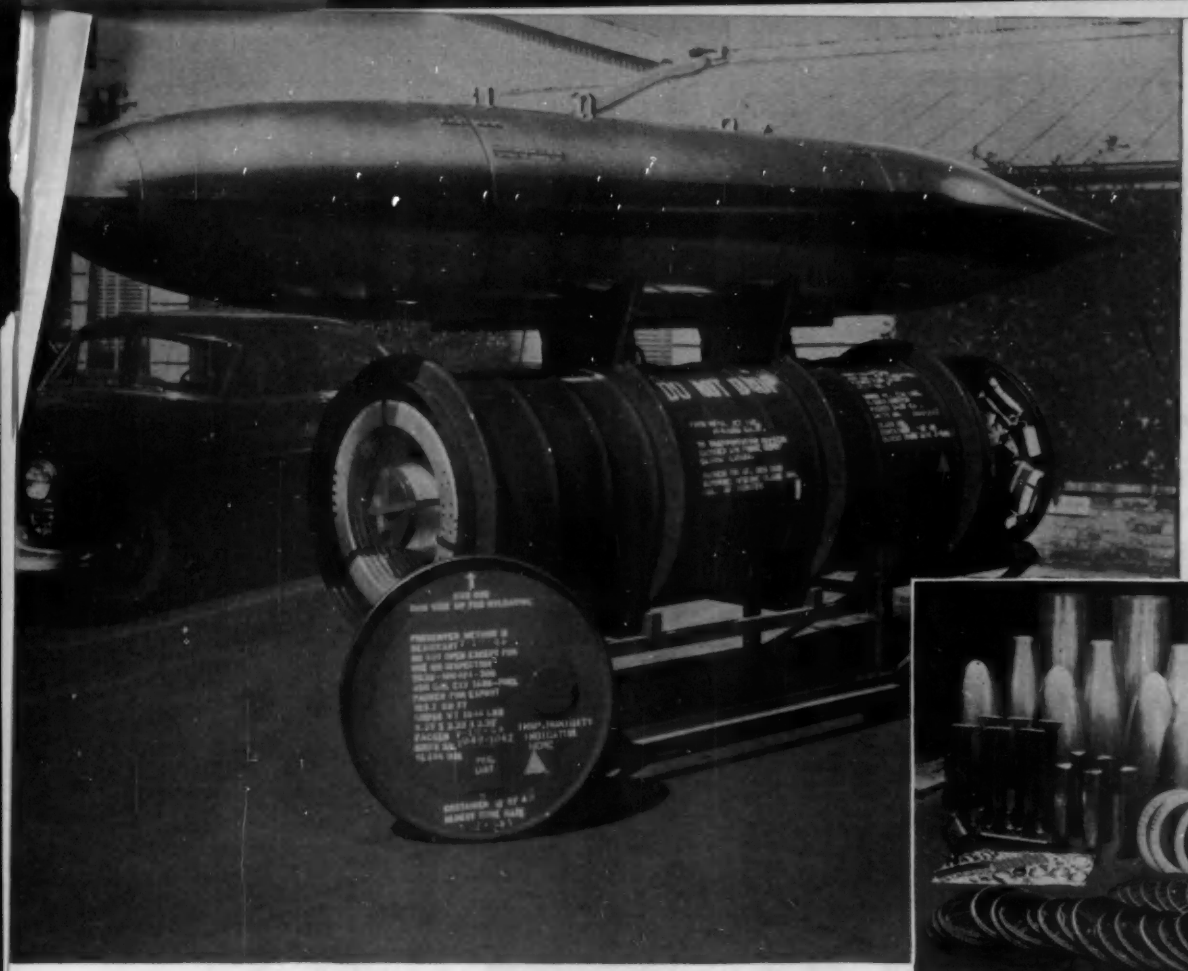
As it turned out, Hardwick & Magee couldn't have made a better drive choice. The Worthington-Goodyear drive combination has proven itself through four years of trouble-free operation.

Find out how this Worthington-Goodyear team work can pay off for you, too. Write for Bulletin V-1400-B7G to Worthington Corporation, Harrison, N. J.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives



This picture shows a COR-TEN Steel container and an assembled wing tank mounted on it for display purposes.

(Below) All these components for six 450-gallon wing tanks are ingenicusly nested and carried in a single Royal Jet Tank Can made of USS COR-TEN Steel. Tanks can be easily and quickly assembled in the field.

How containers for jettisonable fuel tanks—made of USS COR-TEN Steel—save 40% in shipping and storage space—reduce weight 25%—cost 10% less than crates

Shipped six-at-a-time in these COR-TEN Steel "cans," 450-gallon wing tanks for jet aircraft now travel more safely and more cheaply to their distant destinations. Not only are they better protected than ever before against shipping and landing hazards but they are indefinitely preserved in storage.

Royal Jet, Inc. of Alhambra, Calif., developer, designer and manufacturer of these efficient containers, has found COR-TEN Steel the most satisfactory material from the standpoint of lightweight, permanence, ease of manufacture and reasonable cost.

For with USS COR-TEN Steel which is 50% stronger than carbon steel and offers 4 to 6 times greater resistance to atmospheric corrosion they can use light 12 ga. and 18 ga. sheets to build containers of great strength and ruggedness that weigh 25% less than wooden crates.

These steel containers offer other advantages, too. Hermetically sealed and filled with dry air they contain sufficient dessicant to insure minimum moisture content. Since no organic materials are used in the padding, fungus growth and interior corrosion are eliminated. As a result the sealed-in tanks stay factory-new regardless of temperature, climate or length of storage. Containers can be stored in the open for an indefinite period with a minimum of damage or deterioration.

This new packaging technique pays off. By replacing wooden crates, formerly used, with these COR-TEN Steel containers, weight per wing tank shipped has been materially reduced, 40% less storage and shipping space is required and the shipping cost to Europe, for example, has been reduced $21.36 per tank—a saving to the Government, on only 100,000 tanks, of more than $2,000,000.

SOON TO BE ISSUED. Our new "Design Manual for High Strength Steels" contains comprehensive and practical information that you will find extremely useful in designing your product for greater economy and efficiency by the use of high strength steels. Watch our future advertisements for the announcement of the availability of this important publication.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS COR-TEN HIGH Strength STEEL

USS

5-440

UNITED STATES STEEL

DENISON *MULTIPUMP*

VARIABLE VOLUME VANE PUMP

DENISON MULTIPUMP gives you variable volume at constant speed plus constant volume at variable speed

NEW, EXCLUSIVE MULTIPUMP PRINCIPLE makes possible great savings in horsepower . . . by delivering only the oil needed by the circuit.

SIMPLE, UNIVERSAL CONTROL—in one compact unit—combines features available in other pumps only as optional items . . . and, in most cases, MULTIPUMP eliminates circuit components usually needed in addition to the pump itself.

FINGER-TIP CONTROL. Simple hand dial adjusts volume. Volume is maintained by MULTIPUMP regardless of variations in pressure and pump speed.

and in addition...

PRESSURE COMPENSATED, easily adjusted. Can be remotely controlled. Can be vented.

OPERATES COOLER. New Denison design principle circulates oil from tank at all discharge rates, even when pump is compensated.

SEND FOR FACTS. Operating characteristics, sizes and capacities of Denison MULTIPUMP are given in Bulletin 190. Write

DENISON *HydrOILics*

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

THE DENISON ENGINEERING COMPANY
1194 Dublin Road • Columbus 16, Ohio

Automatic film developing sink with top section of Stainless Steel.

Forming edges of top on 100-ton press brake.

Welding z-sections to underside of cooling tray.

How Stainless Steel helps make film developing automatic

DURABILITY, corrosion resistance and good looks are built into this automatic photographic developing sink through the use of Stainless Steel for the entire top section, including the two trays and the center bowl.

Metlmex Corporation, Lewistown, Pa., fabricator of this sink, makes a variety of products, working with both Stainless Steel and carbon steel. Fabricating equipment is used interchangeably with no special tools for working Stainless. The only difference in shop procedure lies in precautions taken to avoid marring the smooth surface of Stainless Steel.

Stainless Steel offers a unique combination of properties—plus ease of fabrication. It's the answer to a wide range of design problems. And when you use it, be sure you get service-tested USS Stainless Steel.

FABRICATING FACTS

Sheets are sheared to size in a ¼" capacity squaring shear and edges are then formed on a 100-ton press brake.

Front, sides, bowl and trays are assembled to form a complete integral stainless steel top unit. Metallic-arc, heliarc, and spot methods are employed in welding temperature controlled trays and cabinets. Developer and fixing trays are attached to unit by riveting one side to stainless steel hinge permitting mechanical agitation.

Stainless steel panels are easily lock seamed to form center bowl section.

After assembly, entire unit is ground and polished to remove weld marks.

SEE THE UNITED STATES STEEL HOUR.

It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS • PIPE • TUBES • WIRE • SPECIAL SECTIONS

5-498

UNITED STATES STEEL

LOW COSTS LIKE THESE...
can save you

Actual cost figures for material and machining in lots of 10,000*
Brass . . . . . $.052 each
Steel . . . . . .068 each
Aluminum . . . .045 each
Brass . . . . . $.065 each
Steel . . . . . .047 each
Aluminum . . . .048 each
Brass . . . . . $.148 each
Steel . . . . . .160 each
Aluminum . . . .107 each
Brass . . . . . $.170 each
Steel . . . . . .190 each
Aluminum . . . .117 each
Brass . . . . . $.062 each
Steel . . . . . .050 each
Aluminum . . . .045 each
Brass . . . . . $.332
Steel 153
Aluminum 185
Material costs of above parts in lots of 10,000
Brass . . $.543 each Steel . . $.189 each Aluminum . . $.290 each
Production costs of above parts in lots of 10,000
Brass . . $.286 each Steel . . $.479 each Aluminum . . $.257 each
Material and Production costs of above parts in lots of 10,000
Brass . . $.829 each Steel . . $.668 each Aluminum . . $.547 each
Cost reduction by using aluminum
34.1% less than brass — 18.5% less than steel
*Figures given for brass and steel parts do not include the large plating costs that would have been necessary if these materials were used. Aluminum required no plating because of its natural attractive finish and resistance to rust and corrosion.

WITH KAISER ALUMINUM STOCK thousands of dollars a year!

Look at these cost comparison figures for the 6 screw machine parts in this camera tripod. It is manufactured by the R. J. Fisby Manufacturing Company of Chicago, a member of the National Screw Machine Products Association.

Frisby effected these savings because of the low material and machining cost of aluminum and because the natural attractive finish of aluminum required no expensive plating as with brass and steel. In addition, aluminum is so light in weight that substantial savings in postage were realized on this direct mail item.

Here's why *you* can cut costs and get better parts by specifying aluminum:

- Your screw machine parts supplier gets up to three times more feet of stock from a pound of lightweight aluminum than he gets from a pound of brass or steel. *Three times as many parts!*
- Your supplier makes other savings that can often be passed on to you. Aluminum may permit him to reduce machine time and extend tool life. It gives him a ready market for recovered scrap. And aluminum often eliminates the need for expensive plating—a major economy that greatly reduces the price of the finished part.
- Better parts can result with aluminum because it gives you a unique combination of advantages, including light weight combined with strength, attractive finish, high resistance to corrosion, excellent conductivity of heat and electricity, heat and light reflectivity.

More and more screw machine parts suppliers find aluminum EASY to machine.

Screw machine operators all over the country are working aluminum on any existing screw machine at both high and low speeds.

Only a few easy changes are required to work aluminum instead of brass. For example, different tool angles are necessary. On long runs, carbide-tipped tools should be used. Simple tool re-designs provide the rakes, clearances and chip-breakers that are best for aluminum.

And to help screw machine shops machine aluminum most effectively, Kaiser Aluminum engineers are available to recommend angles proved best by operators experienced in aluminum.

On your future screw machine parts bids, always ask for the price in aluminum. The savings will be big, and the quality will probably be better!

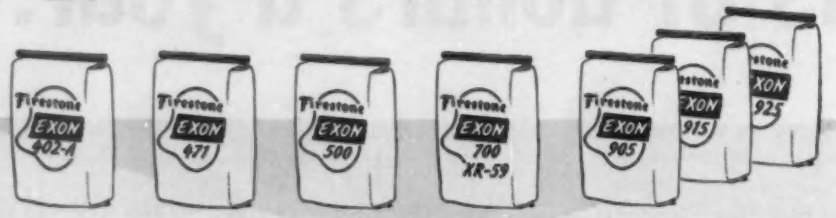
If you would like more information, contact the Kaiser Aluminum sales office listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, California.

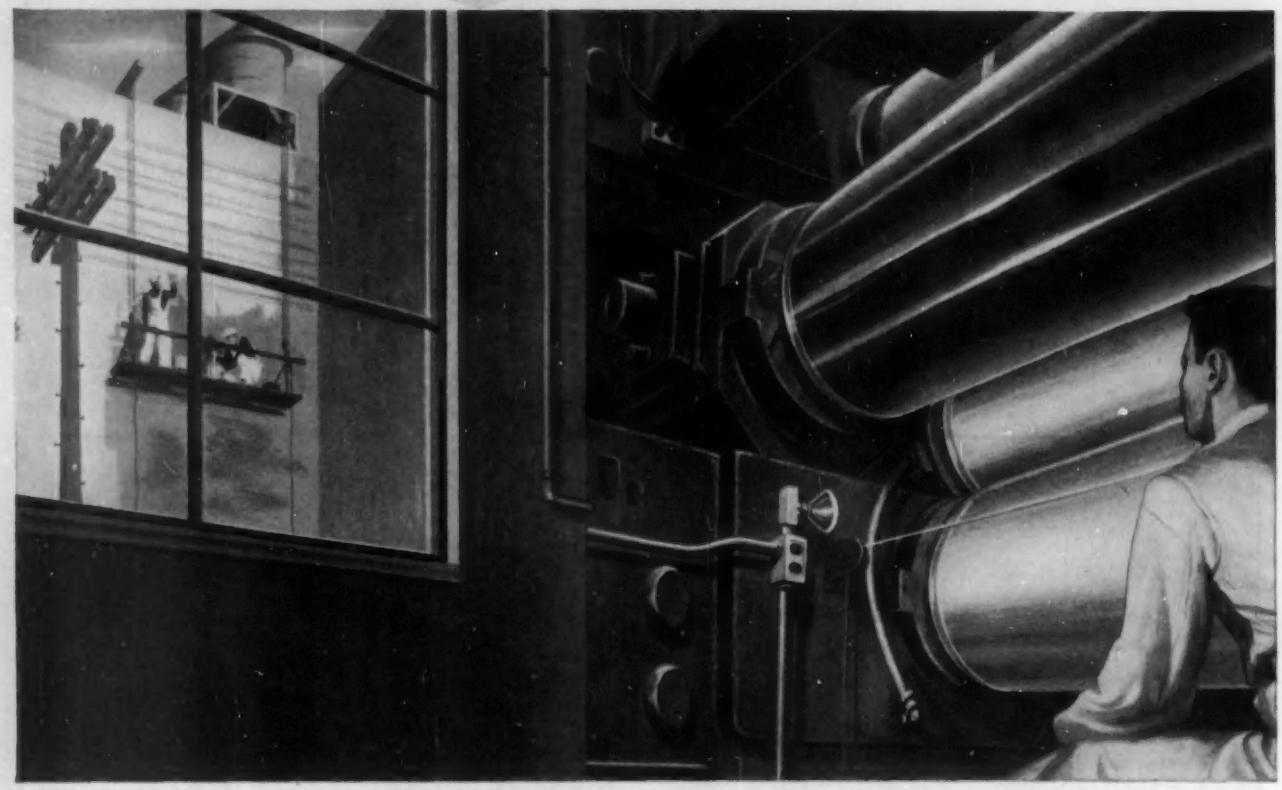
Kaiser Aluminum

setting the pace—in growth, quality and service

EXON RESINS: each one engineered for

Specific Problems





EXON 402-A
specifically to wipe out **CORROSION**

Base resin can be processed into a variety of useful forms, such as sheet pipe and rods. Unplasticized PVC resists industry's most corrosive conditions.

EXON 905-915-925
specifically for **PROCESSABILITY**

Temperature-tailored, they free your processing from restrictions due to temperature limitations. Blend speedily, fuse quickly into top quality products.

EXON 471
specifically for **WEATHERABILITY**

Unmatched for durability in a protective coating. Corrosion resistant.

EXON 500
specifically for **WIRE INSULATION**

Superior electrical properties; color, heat and light stability.

EXON 700 XR-59
specifically for **IMPREGNATION**

Exceptionally fast-fusing latex, compatible with conventional vinyl chloride plasticizers. Resultant films resist grease, oil, water, light.

Firestone

Chemical Progress Week May 16-21

and Specific Uses

EXON 450

specifically for **STRIP COATING**

Good solubility, film tensile strength and durability allow formulations to be based on this one resin alone. Coatings can be spray-applied, and strip off cleanly and easily.

EXON 470

specifically for **SOLUTION COATINGS**

Has excellent adhesion to metals, alkyd and vinyl surfaces. It is compatible with various drying oils, alkyds, phenolics and melamines. Highly soluble in ketone solvents and has good aromatic tolerance.

EXON 468

specifically for **FLOORING**

Increases banbury output 10 to 25%. Fuses fast, processes easier, much more efficiently.

EXON 480

specifically for **RECORDS**

High bulking density and easy processing at low temperatures. Compatible with extender resins.

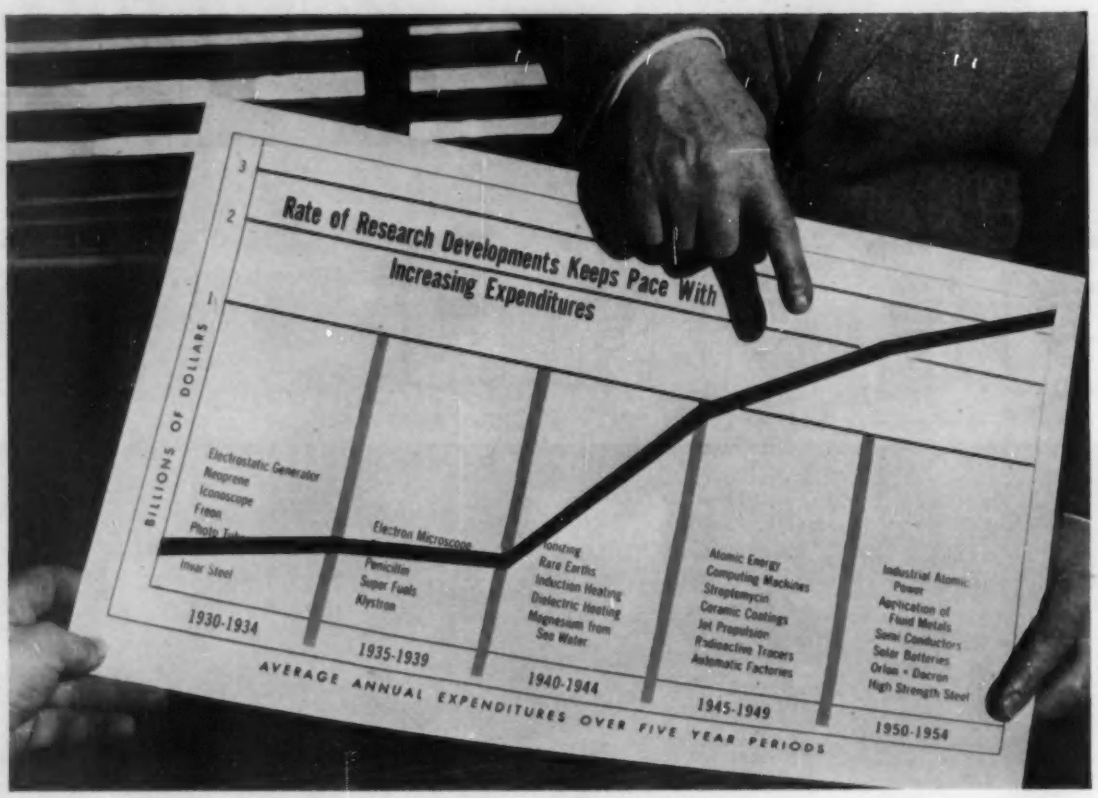
EXON 654

specifically for **PLASTISOLS**

Stir-in type, ideal for slush molding, foam vinyls, coating fabrics and thin film casting. *Needs no grinding.*

ALL RESINS in the ever-growing EXON line bring you short cuts to finer products.
Specific data on these resins are available to you on request. Call or write today.

CHEMICAL SALES DIVISION
FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA., DEPT. 6N
DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY



"But what," the President asked, "has *this* got to do with more advertising in *Product Engineering*?"

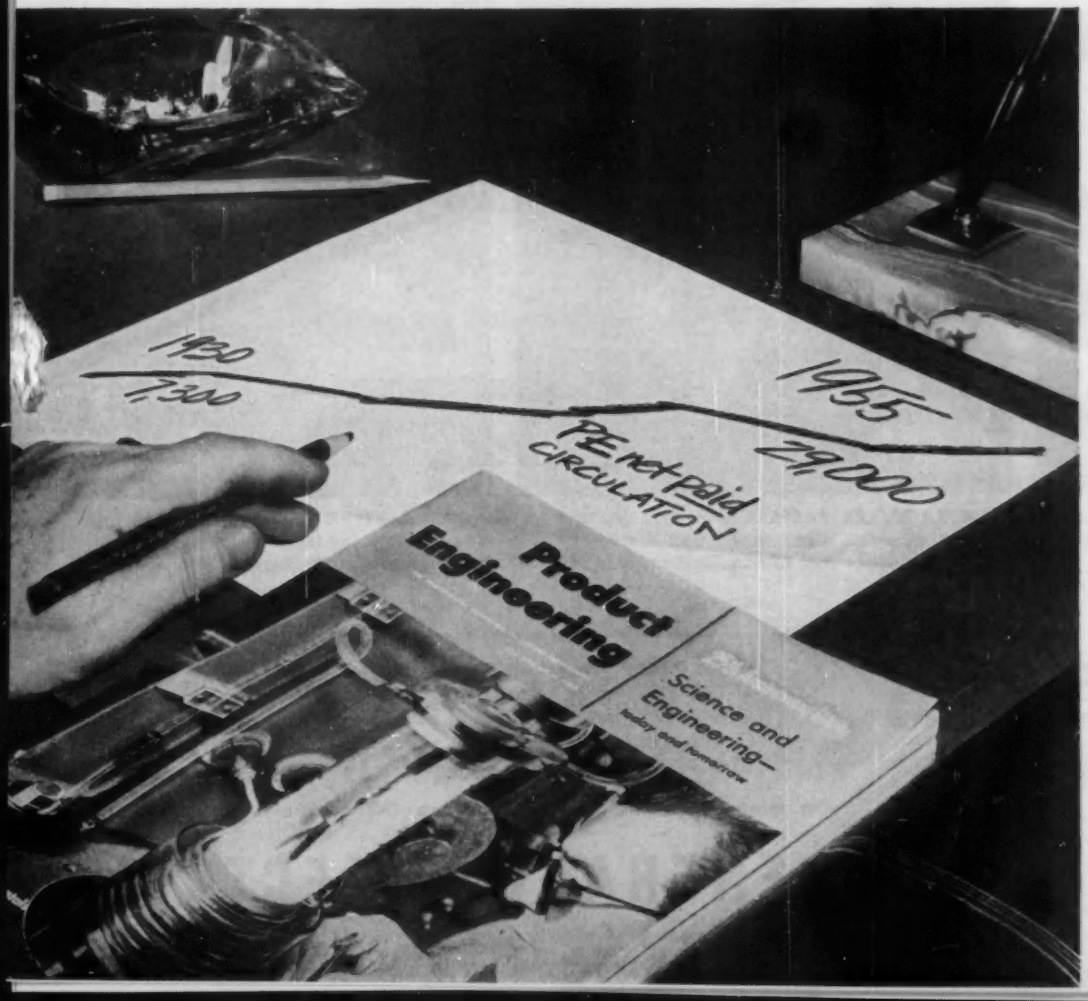
"Nothing else sells design engineers like *Product Engineering* does" has particular significance now, and for the foreseeable future. Record investments in research are resulting in a record number of new developments in materials, electronics, hydraulics, and all other sciences. And as these developments are channeled to Design Engineering for conversion into new and better products, the Original Equipment Market is alive with change and growth, and with both immediate and long-range applications for your parts, materials, components, or finishes.

Growth, change, and new opportunities are synonymous with the Original Equipment Market. And *Product Engineering* is the synonym for efficient, productive advertising in this market. Year after year, advertisers invest far more advertising pages and dollars in *Product Engineering* than in any other design publication. These pages totalled 4,172 in 1954 ... for a clear lead of more than 1,000 pages over the second design magazine.

Product Engineering's **more than 850 advertisers know that "only Design Engineering can make new research discoveries pay off." They also know that, until Design Engineering creates industry's products Purchasing has nothing to buy, Production has nothing to manufacture, Sales has nothing to sell.**

Design Engineering is industry's basic function . . . and basic buying influence. For 25 years, *Product Engineering* has been the basic advertising medium to design engineers. Today, as never before, concentrated advertising in this magazine is your best sales investment in the $28-billion (and growing) Original Equipment Market.

"Only design engineers can make new research discoveries *pay off,"* the Advertising Director said . . ."and nothing else sells design engineers like *Product Engineering* does."



THE MEN
WHO DESIGN
AMERICA'S
NEW PRODUCTS
READ

Product Engineering

ABP ABC

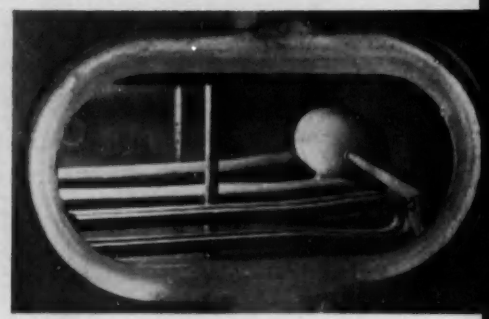
The McGraw-Hill Magazine of Design Engineering
McGraw-Hill Building, New York 36

Nine product designs show how you can reduce costs, get freedom of design with General Electric Calrod* heaters

HEATING LIQUIDS

EASILY FORMED tubular heaters improve paint sprayers. Labor time and amount of thinner are reduced 50%.

MANUFACTURER USES IMMERSION HEATERS in sterilizer because G-E heaters take wear and tear of 24-hour duty—provide sanitary sterilization.



DESIGNER SPECIFIED G-E immersion heaters for steam cooker because they are adaptable to small area.

HEATING SURFACES

G-E TUBULAR HEATERS are used in packaging machine because they can be formed into intricate shapes.

BENT SEVEN TIMES, G-E Calrod tubular units don't break. Tire retreader manufacturer had to send other heaters back for special bending.

MANUFACTURER FINDS G-E Calrod "wrap-around" tubular heaters are easy to install in extruder.

HEATING PROCESS AIR

COMPACT G-E FIN HEATERS require less space, allow maximum air circulation for oven manufacturer.

MANUFACTURER PREFERS G-E strip heaters for air-heating oven. Electric heaters are easily installed; eliminate cost of auxiliary equipment.

SIMPLE PATTERN of General Electric strip heaters for radiant drying bank reduces installation costs.

*Reg. trademark of the General Electric Company.

MODERN HEAT PROCESSING . . .

Tear out this coupon and send for your free copies of the bulletins listed at the right.

Name.....

Company.....

Street.....

City.....State.....

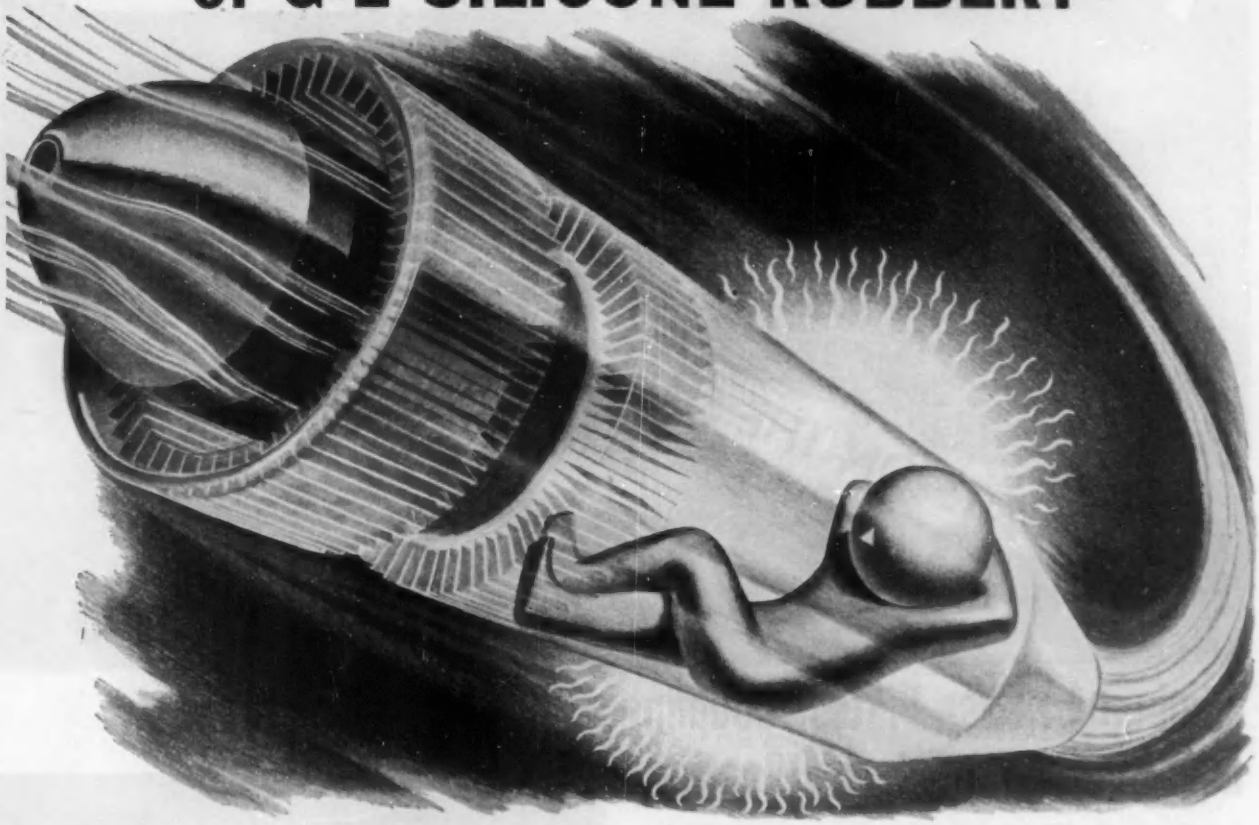
Section D723-2, General Electric Company, Schenectady 5, N. Y.

- ☐ GEA-5077 Heating Liquids
- ☐ GEA-5097 Heating Surfaces
- ☐ GEA-5096 Heating Process Air
- ☐ GEA-5866 Calrod Heaters for Machinery Manufacturers

For more information, contact your local G-E Apparatus Sales Office.

GENERAL ELECTRIC

How can you benefit from the AMAZING HEAT RESISTANCE of G-E SILICONE RUBBER?



Serviceability up to 600 F is one of the amazing characteristics of General Electric silicone rubber that makes it ideal for a host of applications. For example, it's being used for aircraft ducting and oven door seals where *intermittent* temperatures of 600 F are encountered. It provides *continuous* operation at 300-500 F as seals and gaskets in jet and diesel engines, clothes dryers, electric cookers, steam irons, and heat sealing equipment.

Where can YOU use G-E silicone rubber? There's a class for almost every requirement! For example: Class 300 offers the best recovery after compression of *any known rubber!* Class 500 provides flexibility at *—120 F below zero!* G-E silicone rubber is classified according to dominant property for easy selection and specification.

G-E SILICONE RUBBER PROVIDES...

Outstanding resistance to extreme temperatures

Superior resistance to compression set

Dielectric strength stable at high temperatures

Unequalled resistance to aging, ozone, weathering

G-E silicones fit in your future

GENERAL ELECTRIC

SEND FOR A FREE "LIGHTNING SELECTOR"—TODAY!

Silicone Products Department
General Electric Company
Section 53-1D
Waterford, New York

Please send me technical data on G-E silicone rubber, including a free "Lightning Selector" and up-to-date list of fabricators.

Name_____ Position_____

Firm_____

Street_____

City_____ Zone____ State_____

IN CANADA: Mail to Canadian General Electric Company, Ltd., Toronto

FLOATING GEARMOTOR

eliminates: Base Plates, Couplings Line Shaft and External Gearing

The Philadelphia "Floating" GearMotoR is a new concept for powering steel mill roll tables, conveyors, textile machines and many other industrial drives. This motorized worm gear reducer mounts directly on the driven shaft, and requires no mounting provisions other than a simple torque arm . . . the GearMotoR is supported by the same bearings as the drive shaft, thus the power unit is reduced to its simplest form.

Because the Unit actually "floats" with the driven shaft, there is no problem in providing for and maintaining alignment . . . the power unit and the driven shaft become a simple integral unit.

The "Floating" GearMotoR can be mounted in almost any location, and the use of right angle worm gearing permits the GearMotoR to nestle close to the driven machine, thus saving valuable floor and aisle space. Also, special design and sealing features make it possible to mount it in any desired position — motor horizontal, vertical up or down.

The "Floating" GearMotoR is manufactured in both single and double gear reductions offering a wide range of out-put speeds from 9 to 420 rpm. Motors are available in almost any required combination of electrical characteristics ranging in size from 1 to 15 horsepower.

Proof of the outstanding performance and reliability of the "Floating" GearMotoR lies in the many successful installations throughout the United States and Canada.

Send for Catalog F-54, and be convinced.

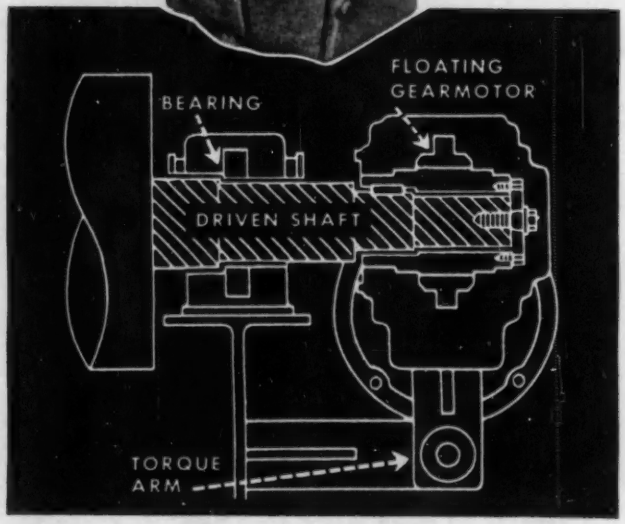


Illustration shows simplicity of assembly and mounting of the "Floating" GearMotoR in the motor-horizontal position. GearMotoR and driven shaft are supported on same set of bearings.
Note compactness of the installation.

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
Virginia Gear & Machine Corp. • Lynchburg, Va.

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

Perspectives

DESIGN AND DEVELOPMENT

NEEDED: MORE ALUMINUM

A few weeks ago, Arthur S. Fleming, Director of Defense Mobilization, announced that the Government was reducing by 150-million pounds the amount of aluminum which was scheduled for its stockpile in the first six months of 1955. Thus, the three major producers—Aluminum Company of America, Reynolds Metals, and Kaiser Aluminum—will be directed to distribute this amount to industrial users. Of greater importance, this diversion from the stockpiling program is not in the form of a "loan" which must be paid back. This action, then, should postpone for a short time an aluminum shortage which many people never knew existed or even threatened.

There was a shortage, however, as was evidenced by the growing number of complaints to the government. This finally forced an investigation by the Office of Defense Mobilization, and the Business & Defense Services Administration, which revealed that the supply of aluminum ingot, both primary and secondary, was insufficient to meet all immediate demands, and as a result serious difficulties were developing in the industrial economy. The situation was so strained in some places that unemployment problems were developing, while in others, companies were turning to the foreign aluminum market for assistance.

CONTROLS ON EXPORTS

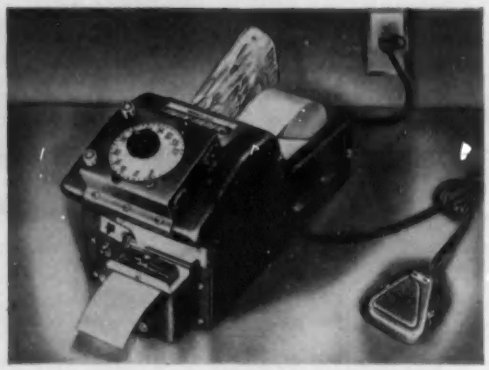
Along with this scheduled stockpile reduction came the announcement from the Bureau of Foreign Commerce that tighter controls were being placed on the export of scrap aluminum. These controls, in effect, will limit the second quarter export licenses for scrap aluminum to a quota of 9,000 tons. This announcement brought a sharp rebuke from the Aluminum Smelters Research Institute who claimed that this was no order at all, as far as any relief to domestic users was concerned. These figures are identical to those of 1954. Also, with the exception of shipments to Mexico, the new order restricts export shipments of primary and secondary aluminum ingot to the 1954 level—about 200 tons a month.

Die casters and foundries depend upon scrap for upwards of 80 per cent of their raw material. The American Die Casting Institute claims that the export of scrap aluminum jumped from 9-million pounds in 1953 to 74-million pounds in 1954. By January of this year supplies had dwindled, and with the demand still high for castings and other foundry products, the cost of secondary aluminum casting ingot jumped from twenty to better than thirty cents per pound. The price remained at that level until there was an indication that the government would enter the picture by cutting back its stockpiling demands.

The small companies will be the first to feel the pinch in a situation such as this. With an aluminum shortage, it is difficult for them to remain on a supplier's list if the company's past purchasing record has not

(Continued on page 125)

Why Bodine Motors were selected for the Marsh Electric Twin-Taper



1 This is a production taping machine called the Twin-Taper...it's used where a volume of same-size cartons have to be sealed.

2 It can be pre-set to deliver two lengths of tape...a long piece to seal the center seam, and shorter pieces to seal the ends.

3 The operator touches a button...out zips tape, accurately measured and moistened. Another button delivers shorter tape.

4 The Twin-Taper is powered by a standard Bodine type NC1-33, 1/20 H.P., 1725 rpm., totally-enclosed, capacitor motor.

5 Meet Mr. H. W. Hempel, vice president, Marsh Stencil Machine Company, Belleville, Illinois, manufacturers of the Twin-Taper.

"Our Twin-Taper requires a completely enclosed motor with special starting torque characteristics, capable of starting up to 800 times per hour. You were prepared to furnish motors with special features by combining your available components, thus giving us a special quality product at the cost of a standard item."

6 Like to read other peoples' mail? See part of recent letter (above) from Mr. Hempel to Bodine's Sales Manager.

BODINE

50th Anniversary

BODINE

fractional horsepower

MOTORS

7 Be sure your motor is as good as your product. For information contact Bodine Electric Co., 2260 W. Ohio St., Chicago, Ill.

BODINE MANUFACTURES FRACTIONAL HORSEPOWER ELECTRIC MOTORS FOR:

adding machines
letter openers
sanders
vending machines
exhaust fans
duplicating machines
portable tools
sound recorders
air conditioners
check protectors
respirators
voltage regulators
x-ray timers
traffic signal timers
stirrers
calculating machines
envelope sealers
diesel governors

. . . and for many other applications.

Ask for a sample copy of "The Motorgram," a bi-monthly publication discussing application and design of fractional horsepower electric motors.

been consistent. To make the situation tighter, small companies return the scrap to their source of supply to be melted, so that they may be assured of future ingot deliveries. Under such an arrangement, the customer usually pays the freight and remelting expense, and the amount of ingot is credited to his forthcoming orders.

PRIMARY PRODUCERS SAY

The producers of primary aluminum maintain that the so-called shortage was caused by conditions that were not representative of actual market conditions, and that many of the companies were trying to build up their inventories because of some dark days which they figured were ahead. This, say the producers, along with the government's regular stockpile grab, made things difficult. Furthermore, if the government would hold back until Anaconda's new 65,000 ton plan got going in June, it would ease the load until Alcoa's new 65,000 plant starts up in Texas later this year.

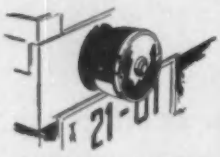
ADJUSTMENT ONLY TEMPORARY

But many people feel that any adjustment made now is only temporary, and that it does not face up to the real problem of a continuing high demand for aluminum. The answer, they say, is a third round aluminum expansion. This proposal was brought up last year, but later dropped after an estimate of aluminum needs indicated that it was not necessary. Actually, the government does not have the authority to go along with another expansion unless there is a shortage for the nation's defense purposes. Last year's refusal for another expansion was not an out-and-out denial, because a third round is being discussed again. The talks have gone so far as to considering new companies for the program. In 1954 the U. S. produced about 1,460,000 short tons of primary aluminum, the largest annual total to date, and an increase of 17 per cent over 1953. Many feel that 2-million tons should be the new target.

ELECTRIC POWER THE PROBLEM

The big problem in producing primary aluminum is the electric power situation; hence, the big interest in getting the government to step into the picture to set up new hydro-electric power plants from which the aluminum companies may obtain cheap power. Another problem is raw materials. To make one short ton of aluminum requires the following materials: 3,800 to 4,000 pounds of Alumina; 1,200 to 1,600 pounds of Carbon Electrodes; 50 pounds of Cryolite; and 70 pounds of Aluminum Fluoride. Each pound of Aluminum produced requires 8 to 10 KWH of electric energy. Allowing for a power input of 35,000 KW per line of 128 pots, a small plant of three lines would need a power plant setup capable of producing about 105,000 KW. To stay on the profit side of such an operation, power costs should not exceed one cent per pound of produced aluminum. The best locations for reduction plants, then, should be where the cost of power is low, and where the power output can be expanded. The hydro-electric power plant is considered the best and cheapest source, particularly when the government foots the big bill of building the dam and installing the necessary generating equipment.

Fewer tools, lower costs, no rejects ...with Tinnerman SPEED NUTS!



A change to Tinnerman SPEED NUT brand fasteners can eliminate production problems in addition to saving important assembly dollars! Here's proof. The Peterson Manufacturing Company, Kansas City, Missouri, formerly assembled its Combination Stop and Tail Lamp with four stamped and tapped brackets. Costly equipment was necessary to manufacture the brackets, and misalignment of holes often made assembly difficult. Damage to units on the assembly line averaged 5%!

Four SPEED NUTS have changed everything! Material costs have been cut a whopping 60%! The tools to manufacture the brackets are eliminated. The easy lead-in provided for screws by the SPEED NUT impression cuts assembly time 20%, increases production by 15%. Misalignment of holes presents no problem for SPEED NUTS and assembly-line damage is completely eliminated!

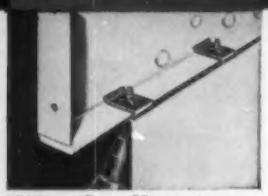
Let Tinnerman help with your fastening problems. Ask your Tinnerman representative or write for complete details on our Fastening Analysis Service.

TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts® FASTEST THING IN FASTENINGS®

TYPICAL USES



"U" type SPEED NUTS cut assembly costs, maintenance on farm equipment.

Special SPEED NUT eliminated production problems on washing machine motor mount bracket.

SPEED GRIPS eliminated costly repairing of truck radiators returned because of weld breaks.

More than 8000 shapes and sizes

Engineers and Education

IN OUR MARCH 1952 EDITORIAL we urged that industry contribute heavily to the support of technical schools and universities. Today that is being done. Almost every day press reports tell of new or increased industrial support for education. Most of it is going to the science and engineering colleges.

Obviously the leaders of American industry fully appreciate the essentiality of leadership in science and engineering. Any nation that fails to maintain such a position cannot be influential for world peace and prosperity. National security goes hand in hand with the level of the education of its citizens.

The institute, college or university is the last step in the formal education of engineers. Most of them obtain their primary and secondary education in public schools. By the time they enter college they have already completed three-fourths of their formal education. Hence the great importance of the public high school.

Most high school courses for preparation for college engineering education are out of date or poorly taught. Some essential subjects are not even given. The fault is squarely in the lap of the public. Salaries for teachers of mathematics and sciences are a miserable pittance. Qualified teachers of those subjects are compelled by economic pressure to obtain higher paying jobs in industry. High school principals and school superintendents are helpless to do anything about it. The school boards have their hands tied by public apathy and the failure of citizens to vote the necessary funds.

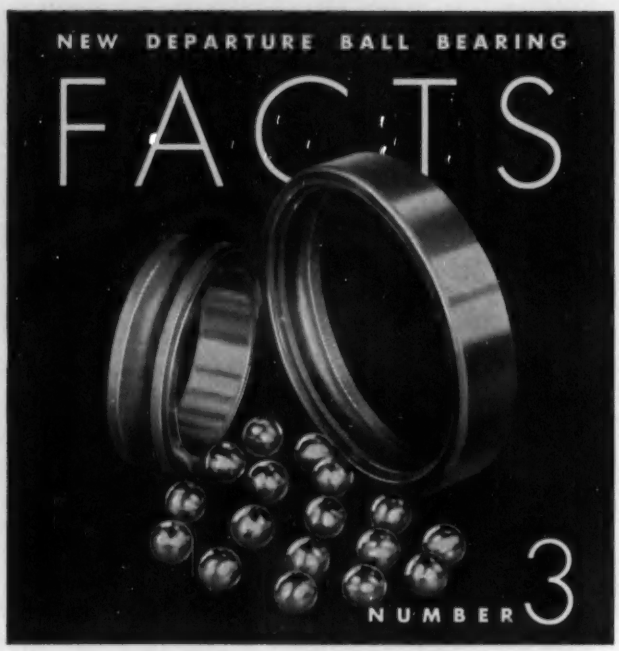
School board elections bring out a handful of voters except when it is a matter of voting down a sorely needed bond issue. Ignorance or lack of realization of the overwhelming importance of engineering education must be the explanation for this apparent lack of public interest.

Here is a public service to which every engineer can contribute. Every engineer who has children in school should be active in the Parent Teachers Association and should urge all other parents of school children to do likewise. Engineers should actively work for the organization of a P.T.A. committee or an independent committee that shall have the sole purpose of building slates of nominees for candidates for election as school board members. There should be strong campaigns to inform the citizens of the importance of education and what is needed to improve their school system.

Of greatest importance is the need to elevate the position of the school teachers, both socially and economically. That is essential and can be done without great delay. No school system can be better than its teachers.

Every engineer should raise his voice, put forth efforts and make his influence felt to the end that our public school system will be elevated to the required level. Industry is doing its share at the college level. It is up to the citizen to bestir himself and do his share at the public school level. The education received by the child today determines events two decades hence.

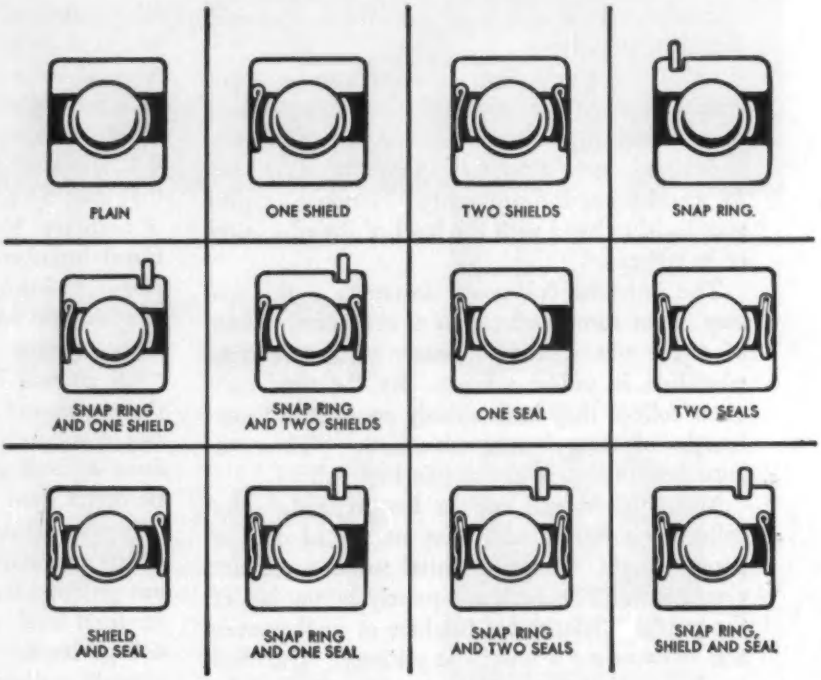
George F. Bodenholt



This "wardrobe" fits standard ball bearings to CUSTOM OCCASIONS

Versatile is the word for New Departure standard ball bearings! For these bearings may be obtained in a wide range of *standard* variations (as shown below), opening a tremendous range of uses to the engineer. In other words, a standard bearing has a "wardrobe" which fits it for very nearly any occasion!

New Departure Single Row Conrad-type bearings, with standard variations available, illustrate the "wardrobe" principle which makes these ball bearings, with their dual load-carrying ability, the most readily adaptable of all bearing types.



Virtually any mounting or operating requirement within a wide range of usage is met perfectly by a *standard* New Departure ball bearing, in conjunction with shields, seals, snap ring, or combinations thereof. Shields protect the bearing from ordinary dirt both before and after mounting and, in many cases, provide adequate retention of lubricant. Seals give positive protection against dirt of every kind and make possible enclosed lubrication for extended or even lifetime service. Snap rings allow positive location in housings lacking inside shoulders. Whenever a design or engineering problem involves ball bearings, think of New Departure. Highly experienced ball bearing engineers are always ready to work with you.

Send for Booklet BA-2 on ball bearing application

NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

RADIOISOTOPES as design tools

Properties of eight radioactive materials of special value in engineering testing.
Three examples of effective use as a development tool.
Probable direction of future development.

ARTHUR M. SMITH
Radioactive Materials Laboratory
Engineering Research Department, Ford Motor Company

What Is An Isotope

EACH ELEMENT in its normal state has a different number of electrons surrounding the nucleus; the number and the energy of these electrons determine the chemical properties of the element. The nucleus of an element contains positive charges of electricity equal to the normal negative charge of the electron cloud surrounding it; the nucleus also includes neutrons which have no charge but contribute to the total mass of the atom. Atoms of the same element may contain different numbers of neutrons; these "isotopes" will have similar chemical characteristics but may have quite different nuclear properties.

Since the advent of particle accelerators and nuclear reactors it has been possible to add either charged particles or neutrons to an atomic nucleus. This changes the atom to a new isotope of a different element if a charged particle is added, or it changes the atom to a new isotope of the same element if a neutron is added. In many such transformations the nucleus of the new isotope is unstable and will give off high-energy electrons and electromagnetic radiation. This is radioactive decay; electrons given off are beta rays and electromagnetic radiations are gamma rays. In addition to beta and gamma radiation, naturally radioactive elements sometimes emit alpha radiation.

For a detailed discussion of these basic concepts, types of radiation, methods of isotope production, and a two-page table listing characteristics and applications for over 100 radioactive materials see "A Primer on Radioisotopes," October 1952, page 177. Article includes a glossary of terms and briefly discusses uses in measurement, testing, control and product development. A summary which includes the above table in full appears in the Annual Handbook for 1953, page A-15.

RADIOISOTOPES AS TRACERS have been used in a variety of ways; in piston ring wear measurement, for example, where traces of wear products in the engine lubricant are measured radioactively. Tests for leaks in engine cooling systems can be made with tracers in the coolant; filter efficiency can be measured with tagged contaminants; automotive engine oil consumption may be determined

Radioisotopes for Product Testing Applications

Element	Radioisotope		Radiation, mev			Typical applications as a	
	Atomic Wt.	Half-Life	Alpha	Beta	Gamma	Radiation Source	Tracer
Cobalt	60	5.3 years	....	0.32	1.17; 1.33	Radiography	Oil tracer; piston ring rotation; filter efficiencies
Cesium	137	37 years	....	0.51 1.17	0.66	Radiography	
Calcium	45	152 days	....	0.25	None		Passage of soluble salts through concrete; gasket leakage
Iron	59	45 days	....	0.26 0.46	1.1 1.3		Wear measurements
Carbon	14	5500 years	....	0.155	None		Oil catalysis; soil for measuring cleaning efficiency.
Polonium	210	138 days	5.3	....	None	Air Ionizer	
Lead (RaD)	210	22 years	5.3	1.17 (RaE)	None	Air Ionizer	
Yttrium	90	2.6 days	....	2.18	None		Gasket Leakage

by measuring activity in the exhaust of engines having contaminated oil. In blast furnaces modern scintillation detection equipment makes it possible to test retention of powdered ore concentrates without disrupting furnace operations or introducing safety hazards.

Radioisotopes are also used as sources of radiation with the active material itself never becoming mixed with the substance being tested. Radiographic inspection of castings and thickness gauges for production of sheet material are typical examples. A radioactive air-flow measuring device, which utilizes alpha radiation to ionize air, also falls into this category and will be described later.

RADIATION PROPERTIES USEFUL IN DESIGN TESTING. In the selection of an isotope for an engineering test application the half-life, type and intensity of radiation and chemical properties are the more important considerations. Properties of eight isotopes of particular interest in design testing are listed in the accompanying table.

Half-life is the time required for 50 per cent of the atoms present at the beginning of the period to undergo radioactive decay. In a test covering an extended period of time an isotope with a very short half-life would not be suitable. If the penetration of thick sections of steel is required, an isotope emitting an energetic gamma photon must be chosen. If ionization of air is desired, a beta or alpha source is most suitable. Where the radioactive material will be used as a tracer in chemical reactions, an isotope having proper chemical characteristics is necessary. Thus, the half-life, radiation and chemical characteristics must be considered in the selection of the most suitable radioactive material for any specific application.

One additional factor must always be considered and that is personnel safety. Generally this problem is not difficult, but it must be analyzed and AEC regulations must be observed.

RADIATION CHARACTERISTICS. Alpha rays are composed of helium nuclei and frequently have a kinetic energy of several million electron volts. While they do not penetrate matter freely (a few centimeters in air or less than 0.1 millimeters in solids), alpha particles react violently with matter leaving great quantities of ionization along their path.

Beta rays have approximately 1/7000 the mass of alpha rays and only a single negative charge. They penetrate matter more easily than alpha rays and have ranges of a few meters in air or a few millimeters in the lighter solids. The ionizing action of beta rays is less concentrated than for alpha rays. Range of both alpha and beta rays in matter is a function of the initial energy and the material penetrated. Gamma rays, or high-energy electromagnetic radiation, are never completely absorbed. They have no mass or charge and easily penetrate matter; each ½ in. of steel penetrated will absorb about 50 per cent of the remaining medium-energy gamma rays.

Applications of Isotopes

COBALT 60 is one of the most widely used radioactive isotopes. The half-life of 5.3 years combined with energetic gamma rays make it a useful isotope for radiography where the problem is detecting voids and porous spots in castings. Cobalt 60 is ideal for this application because very small fragments can be made highly radioactive. Such a concentrated source of radiation permits more detailed shadowgraphs can be made in a given exposure time. Cobalt 60 is useful in testing steel sections 1 to 6 in. thick. Thinner samples require a less energetic gamma ray; the penetrating power of the cobalt 60 radiation is too great for sufficient absorption in thin sections to give a good distinct shadow.

Other uses for cobalt 60 include the tagging of mechanical parts (piston ring rotation as described later) and particles as tracers for filter efficiency studies. Also, cobalt napthenate, an oil-soluble substance usually used as a paint drier, can be made from cobalt 60 for use in oil tracer experiments.

CESIUM 137 is used principally in radiography where the need is for a concentrated source of radiation less energetic than cobalt. Cesium is becoming a popular source,

and the price is going down as demand increases. Useful life is longer than cobalt because of a 37 year half-life. The lower energy gamma photon makes safety shielding easier and gives better sensitivity to porosity in thin test specimens.

CALCIUM 45 has a rather low-energy beta ray radiation, and will penetrate only a small quantity of matter (about 0.020 in. of steel), Thus, radioactive calcium can be easily shielded for safety purposes. Calcium is retained in the body, however, so it is a relatively hazardous element where ingestion is possible.

Calcium may be used as a tracer to follow the element through any chemical process. It could be used to make dilution measurements of solutions (concentration is proportional to the quantity of activity in equal volume samples). The use of calcium in gasket leakage work is described later.

IRON 59 is the principle radioisotope produced when iron automotive parts are irradiated with high neutron fluxes in nuclear reactors. In irradiated iron or steel parts the proportion of molecules changed to iron 59 is so small that the chemical and physical properties are essentially unchanged, yet a significant amount of radioactivity is produced.

Automotive parts are usually irradiated to make possible the detection and measurement of small quantities of wear products in the lubricants used. With this technique, very small quantities of worn material can be detected and wear rates frequently can be determined in only a few minutes running time. Considerable care must be taken to interpret the significance of short-run wear measurements, however, because wear is significantly affected by the conditioning the parts receive immediately prior to the test.

One other method of making wear measurements has been utilized at the Cincinnati Milling Machine Co. Cutting tools have been irradiated and the transfer of tool material to the chips measured. Tool wear rates have been measureable after only a short test period, thus saving tons of stock in the testing of cutting tools.

Iron 59 emits both beta and gamma radiation so a variety of measuring techniques are available which may be tailored to a particular application.

CARBON 14 is frequently used to tag hydrocarbons, a good example of the specificity with which isotopes are frequently applied. Not only can a particular hydrocarbon out of the many in any fuel or lubricant be tagged but it can be tagged in a particular point in the hydrocarbons chain to aid in investigating cracking processes.

Because of the low energy of carbon 14 radiation, measurements usually are difficult to make. Thin-window Geiger counters can be used on very thin samples but frequently it has been necessary to incorporate the test sample into the gas used in the counting chamber.

POLONIUM 210 emits a 5.3 mev alpha particle which is capable of expending this energy within 1½ in. of air. This results in relatively large quantities of ionization in a concentrated space which is useful for air flow measurements, as described later, and for the dissipation of electrostatic charges.

The disintegration of polonium is the last step in the radium decay series. Pure polonium (radium F) then is a source of only one type of alpha particle. The half-life of 138 days is short for many applications where continuous operation is desired. For long-time operation radium D with a half-life of 22 years may be used. It has very weak radiation which is ineffective in most situations but decays to radium E which has a short half-life and emits an energetic beta particle in the process of decaying to radium F. The radium D source emits both the radium E beta and the polonium alpha, and the half-life is 22 years as a consequence of radium E and F being "daughters" of radium D. A short half-life "daughter" in equilibrium with a long half-life parent will appear to have the half-life of the parent because the daughter is continuously replenished by the parent.

YTTRIUM 90 is an isotope of an element which is not in very wide use, but illustrates the many possibilities of new materials in tracer technology. It has a short half-life, an energetic beta particle which is easy to detect, and it is relatively safe from ingestion. A continuing supply is available by chemical separation from a stock of long-lived strontium 90.

Safety Considerations

The Atomic Energy Commission is required by statute to supervise the distribution and use of artificially produced radioactive materials in this country. To accomplish this control the Commission has provided a system of authorization for each procurement of radioisotopes. For the first procurement of radioisotopes by a laboratory AEC forms 313 and 313a are required. Form 313 includes the qualifications of the person directly responsible for the use of the material, a description of the isotope requested, a statement of the proposed use and methods, and other miscellaneous information. Form 313a includes a description of the isotope handling facilities and equipment available in the laboratory and of the general procedures which will be followed to insure the safety of personnel and property.

After delivery of a radioisotope the AEC requires keeping a log of the use and disposal of the radioactivity, along with a complete current inventory of the isotopes on hand in the laboratory. Disposal services for waste activity are available both through the national laboratories and private companies.

Safety precautions required are a function of the hazard involved. Quantities of radioactivity too small to be a serious hazard but adequate for many experiments can be purchased without AEC authorization. Natural potassium salts contain measureable radioactivity and could conceivably be used as a radioactive source in many experiments. There are many applications which do not require more than a few hundred dollars for instrumentation and facilities, and only rudimentary safety precautions are necessary, even when the quantity of activity in use requires AEC authorization.

Two types of hazard must be considered in radioactive applications. Where the radioactive material does not enter into a reaction but is used as a radiation source only, the use of shielding and special tools can keep the radia-

tion dosage received by the body to below permissible limits established by the AEC. The use of monitoring equipment, film badges and pocket ionization chambers make this a relatively easy job for the low levels of activity used in engineering applications.

The use of radioisotopes as tracers frequently introduces the possibility of ingestion. Some elements are retained tenaciously by the body. If a radioisotope of such an element is ingested the radiation damage is continuous until the activity is exhausted or the unstable atoms are gradually eliminated from the body. Small ingested quantities of radioisotopes can be hazardous and adequate precautions for each particular situation must be devised.

Radioisotopes generally are considered to be extremely hazardous because of atom bomb publicity and the extreme precautions practiced at AEC installations. Radioisotopes are hazardous but so is a five gallon can of gasoline. The difference between the hazards of a tracer-level laboratory and a high-level laboratory which requires lead walls and expensive remote handling equipment may be compared to the difference between equipment for storing a five gallon can of gasoline and a storage field for millions of gallons of gasoline. The costs and problems depend on the quantity involved.

Bright Future

The medical field was first to find widespread uses; the chemical specificity was ideal for medical applications where a given element was to be traced. Industrial applications have been concentrated principally in the field of research and development with production control applications being of secondary importance. All of these fields are well established and may be expected to flourish as instrumentation and techniques improve.

Product engineering applications of radioisotopes have been slow to develop for a variety of reasons which do not seem to be basic. A product engineer responsible for the design, development and testing of this product, should find a variety of applications.

RADIOISOTOPES AS DESIGNED-IN COMPONENTS. Luminous dials of watches frequently contain more radioactivity than is used in a typical tracer experiment. Naturally radioactive radium is not controlled by AEC. While the AEC is hesitant in permitting the incorporation of artificial radioisotopes into any product for public consumption, where there is no public hazard AEC approval is possible. Several products such as beta ray thickness gages for production thickness control are on the market. Authorization for such instrumentation is obtainable for use within business establishments where control over the use and disposal of the radioactive sources is possible. Instruments and sources are sometimes leased, and owners maintain required safety precautions.

The atomic battery for supplying small quantities of electrical power for extended periods of time may some day be used in saleable products.

Automatic control mechanisms for the larger products such as public elevators would seem to be feasible using radioisotopes. An elevator could be stopped automatically at the correct position by the use of radiation which, unlike a photoelectric light source, would be unaffected by dirt.

In expensive heavy-duty diesel engines the wear rates of

Measuring Piston Ring Rotation

Measurements of ring rotation during normal engine operaiton were needed to evaluate ring "wear in" operation, but movement of the ring was not directly observable. The position of the ring gap in operating engines was followed, however, using a small fragment of radioactive cobalt empedded in a cavity of the ring.

Selection of Isotope

Cobalt wire was chosen for this application because:

1. Cobalt 60 has a sufficiently energetic gamma emission to penetrate the engine block.
2. Compact source (0.5 mm dia., 1 mm long) having adequate radioactive intensity was available from Oak Ridge.
3. The long half-life of 5.3 years was an advantage since tests might run for some time.

Installation

To install the active wire in a piston ring, a hole was drilled and the entrance to the hole was tapped as shown here. A threaded brass plug was fitted into the entrance of the hole to encapsulate the source and prevent spread of contamination if particles were abraded from the wire.

Only moderate shielding was required in inserting the radioactive wire because the radiation intensity at 6 in. from the wire was below the tolerance level for continuous exposure. The wire was handled with forceps, however, and the operation was planned to require minimum exposure time for the hands.

The assembly of the engine required no special techniques other than arranging that personnel remained close to the radio-active source. After the engine was assembled, there was no possibility of personnel receiving as much as tolerance dosage. The only other safety precaution required was periodic checks for activity in the oil to make certain that the encapsulation of the source remained perfect. Since relatively small quantities of ingested cobalt are hazardous, great care was essential to prevent accidental ingestion.

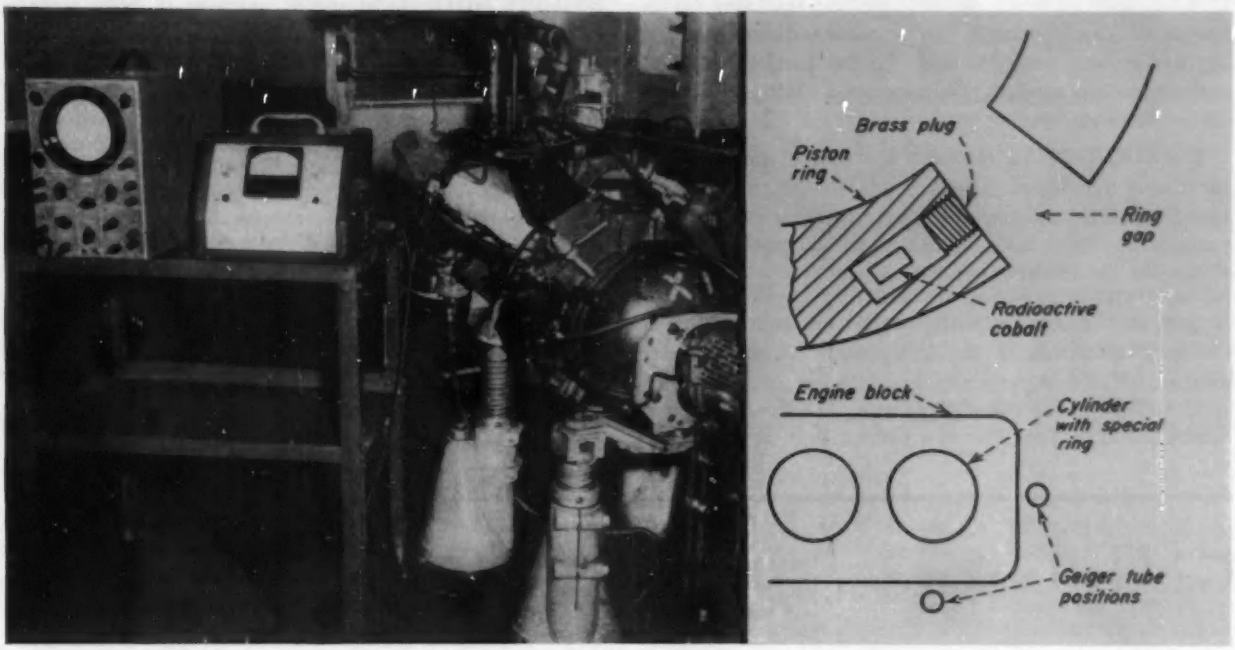
Geometrical Considerations

The measurement of ring gap position was done with Geiger tubes positioned as is shown in the diagram. Each Geiger tube responded with an increased counting rate whenever the ring gap approached the tube. Using information from the two tubes the approximate position of the gap was shown through 180 deg of rotation which proved adequate.

Radiation Measurements

Since neither precision nor high sensitivity was required an inexpensive Geiger tube was used. These tubes were protected against rough handling by brass cylinders and keeping operating temperatures below 90 C prevented tube failure.

The Geiger pulse rate was measured with a monitor, and also by a scaler which furnished a pulse to a 1 ma



To measure piston ring rotation during wear a tiny piece of radioactive cobalt-60 wire was embedded in the end of the ring; Geiger tubes arranged as shown were connected to a monitor to show when the ring gap passed the tube. The use of two tubes connected to a scaler and recorder gave more precise data for the 10-rpm rotational rate found.

recorder for each 100 counts. With the scaler and recorder the average count rate could be determined from the time between pulses. With the monitor the reading is effected by the previous count for a period of several times the time constant of the circuits. Therefore, for counting rates of up to 12,000 per minute and piston ring rotation rates below 10 rpm, the scaler method gave better results than the monitor or rate meter. Under other conditions a rate meter might be more desirable.

Limitation of the Method

This technique is limited to a small number of cycles per second. Maximum detectable cyclic rate is a function of the maximum and minimum count rates, the manner in which the count rate changes with time, and the system used for detecting average count rates during short increments of time.

The precision with which the average count rate may be determined is a function of the number of pulses occuring during the time period. These are randomly spaced pulses. The measured count rate can be expected to be in error by the square root of the true count rate for one-third of the measurements. The probable error thus is much smaller for a larger number of counts.

The scintillation counter can operate at much higher rates than a Geiger tube because there is less "dead" time after each pulse. Therefore, a scintillation counter would be used for a test involving a high cyclic rate.

---

radioactive parts could be used to indicate the optimum time for engine overhaul.

Gas ionizing sources for cold-starting flourescent lamps are under consideration; ionizing sources to prevent the accumulation of static electricity on phonograph records are obtainable commercially.

Although some of these types of products are presently available on a limited scale, they all represent the classes of applications which may be expected to expand.

DEVELOPMENT AND TESTING APPLICATIONS. Future uses in development and testing applications will probably be similar in character to those described in detail here although more widely applied. The general types of testing which will prosper will include:

WEAR TESTING where life testing indicates undesirably high wear rates in a mechanical product. It will become common practice to evaluate changes in lubricants, materials, and mechanical designs by use of radioactive techniques. Micrograms of worn material are detectable.

ACTIVATION ANALYSIS. Neutron irradiation and radiation analysis to determine atomic composition of a material can serve an analysis function similar to a spectrograph. Nuclear radiations can be used to identify the various elements. While this may not become as universally applicable as spectrography, the construction of nuclear reactors in various sections of the country will encourage activation analysis work.

GENERAL TRACER WORK. Where small quantities of material are to be followed through processes, radioisotopes provide a possible method for tracing the material. The problems which fall into this category are many and are varied in nature; but the measuring processes required

to trace material using radioisotopes are relatively simple. Frequently, measurements can be made without interrupting the process being studied. Tagged particles for filter evaluations and similar applications will multiply as radioisotope facilities become available.

RADIOGRAPHY. Recently the cost of casesium 137 for use as radiography sources was sharply reduced. Although a single radioisotope source of radiation is not as versatile as a good X-ray machine for radiographic applications, the investment required to provide a radioactive facility for an engineering laboratory is very low.

One of the least exploited values of radioisotopes is the great quantities of radiation energy which are being disposed of as waste products from nuclear reactors. Food sterilization is being investigated using radiation from gross fission products, but little else has yet been done.

EDITOR'S NOTE—Eight specific examples of early applications for tracer materials were shown in "Radioisotopes in Industry and Research," in *Product Engineering*, May 1951, page 170; one example was the use of iron 59 in a study of piston ring wear. A recent article, "Investigating Friction and Wear With Radioactive Tracers," in the Annual Handbook for 1954, page A-10, reports a study of the effect of lubricant, material composition and metal transfer.

Applications of isotopes in product testing have been reported in several recent issues: "Radioactive Tires Used in Wear Tests," September 1951, page 195, in which radioactive phosphorous was measured in tire tracks. "Radioactive Cobalt Helps Explain Why Porcelain Enamels Adhere," June 1952, page 188; cobalt oxide was added to frit to measure diffusion in iron base. "Isotopes Can Control Automatic Processes," July 1952, page 178; strontium-90 used as radiation source in system for continuously indicating weight of coatings on abrasive product. "Radioactivity Speeds Up Industrial Research," March 1953, page 197; use of activation analysis in measuring impurities in germanium of 1 part in 100 million.

Gasket Leakage

In developing new engine designs coolant leaks may result from internal faults in experimental castings and through gasket faults. A technique was needed to find the origin of leaks and determine whether design changes were advisable. Use of a soluble radioisotope in the cooling water offered some promise, on the assumption that activity would be deposited at any point where liquid evaporated to dryness. After running a test the gasket could be removed and placed in contact with X-ray film to show the leakage pattern.

Selection of a suitable radioactive tracer was the critical factor in the solution of this problem. Tracer requirements were: Solubility in water, chemical compatibility with the coolant systems, stability at combustion chamber temperatures, and a type of radiation giving good film sensitivity and low personnel hazard. The isotope required a half-life sufficiently long to permit a series of tests using one shipment of radioactivity but short enough to ease the problems of decontamination.

The isotope most successful to date is yttrium 90. It has a half-life of only 2½ days; the radiation is 2.18 mev beta, and there is no accompanying gamma radiation. As a practical matter the gamma radiation from impurities did furnish a modest radiation problem in the handling of a 100 millicurie unit.

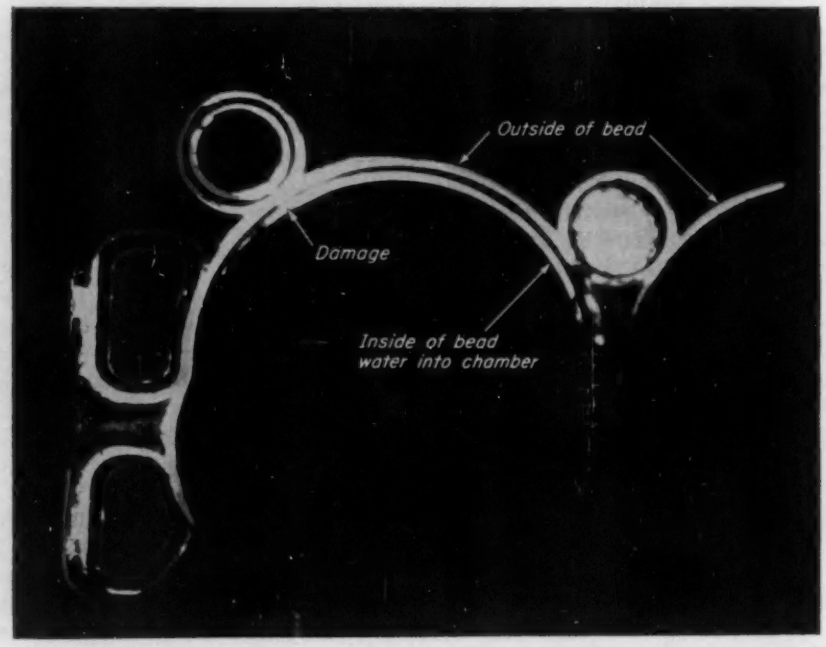
The isotope was furnished by Oak Ridge in the form of yttrium oxide. This was dissolved in hydrochloric acid giving yttrium chloride which is water soluble. Yttrium chloride was not entirely stable in the collant system since it gradually deposited out on the water jacket and radiator walls, but this factor actually turned out to be helpful. When uncoated sheet steel gaskets were used, the activity was deposited along the leakage path, thus locating the path of leakage as well as the spots where evaporation took place. One other difficulty encountered was an impurity with a 70-day half-life which became an inconvenient contaminant of the engine after a few weeks as the yttrium died out. Yttrium 90 chemically separated from strontium 90 should overcome this problem.

Permissible Operating Level

Impurities must always be considered when evaluating personnel hazards. N.B.S. Handbook, "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water," may be used as a guide in these computations. Although yttrium 90 is not listed, the tolerance quantity a person may take regularly in water is quite high because of the short half-life.

Results of Tests

In preparation for the test, the lacquer coating was removed from the gasket and a chisel mark made near a water hole. The engine was run for 4 hr. with 2 millicuries of yttrium 90 dissolved in the coolant. The gasket was taken off and placed in contact with X-ray film in a light exposure case overnight. As shown below, water leakage paths are well defined.



Air Flow Measurement

A method of measuring air flow was needed which could make precise measurements at rates from 2 to 500 cfm, with a minimum range of 20 to 1 for any one unit. Ionization of air by alpha particles offered an answer. In the absence of any air flow ions formed between the alpha emitting surfaces are collected on the ion chamber electrodes. With air flow, some of the ions are blown from the ion chamber and are collected completely by the collectors. The collector current is amplified to give a reading roughly proportional to air flow.

The ion clouds of the present models of the anemometer are formed by the ionizing action of the alpha rays resulting from the radioactive disintegration of polonium 210. These alpha rays are particles (helium nucleii) with an energy of 5.3 mev. As the alpha particles pass through air, ions are formed at a fairly uniform rate of about 10^5 ion pairs per in. for $1\frac{1}{2}$ in. At the end of this path, all of the alpha energy is exhausted and the ionizing action comes to an abrupt halt. The exact range and specific ionization are a function of air density.

An alpha activity of about 0.5 millicuries was used in the first models. With the present electrode spacing most of the alpha particles strike the opposite electrode before all of their energly is expended.

One of the problems connected with the use of polonium for an alpha source is its relatively short half-life of 138 days. This results in small but significant calibration changes in a month and in the critical reduction of ion current in a few years. Radium D which is a lead isotope with a 22 year half-life has been used successfully in place of polonium.

Measuring Air Speed

Velocity with which the ions move is proportional to the product of the mobility of the ions and the electric field strength. Where the air mass is also in motion, the net velocity is a vector sum of the velecity induced by the electric field and the air mass velocity. A current measuring device inserted in the path between the bottom electrode and ground as shown in the diagrams will indicate only the positive charges collected by the bottom plate. Negative charges collected by the positive plate will not be indicated.

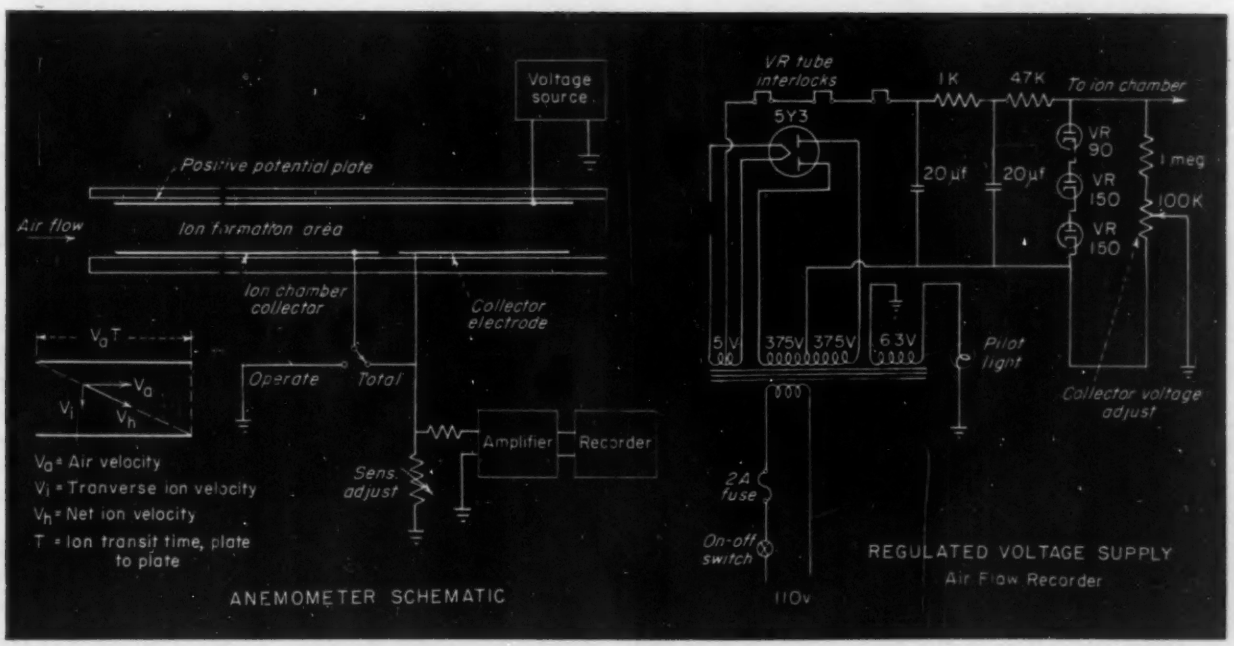
Positive ions were chosen for collection because the cloud of positive charges exhibits only one mobility. The negatively charged cloud is made up of a mixture of electrons and negative ions in proportions dependent on the elapsed time since ionizing, air composition and other complex effects. The electron collection is at a much more rapid rate (10,000 times) and a change in the ion-electron ratio would cause a substantial change in the anemometer performance if negative charges were collected.

Assuming that ion density is uniform between the plates and zero elsewhere, that the electric field is uniform everywhere between the plates, and air velocity is uniform across a transverse section with no ion recombination, then the ion paths are all parallel and are in a direction determined by the vector sum of the two velocities. The response of this idealized system thus is proportional to the air velocity. Actually, the linear response is confined to the region where 50 to 100 per cent of the ions are collected and a non-linear response in the 0 to 50 per cent ion current region. Plate spacing, ion chamber length and applied collecting potential are the principle design variables.

The complete air flow meter (see diagram) includes a recording milliameter resting on a housing for a U-shaped air flow path which incorporates the anemometer. This arrangement reduces the beta radiation to a safe limit for personnel near the entrance or exit aperatures. This housing also contains the control circuits and a regulated voltage source for the ion collector. A stabilized d-c amplifier is on the bottom shelf.

Collector Voltage Supply

Because the calibration of the instrument is a direct function of the collector voltage, a regulated voltage source is essential. The circuit shown here has proved satisfactory. The ion chamber current is approximately 0.1 microamp and there are no difficult problems involved. Control circuits provide a means for checking the voltage of the collecting potential and for calibration under various air temperature and pressure conditions.



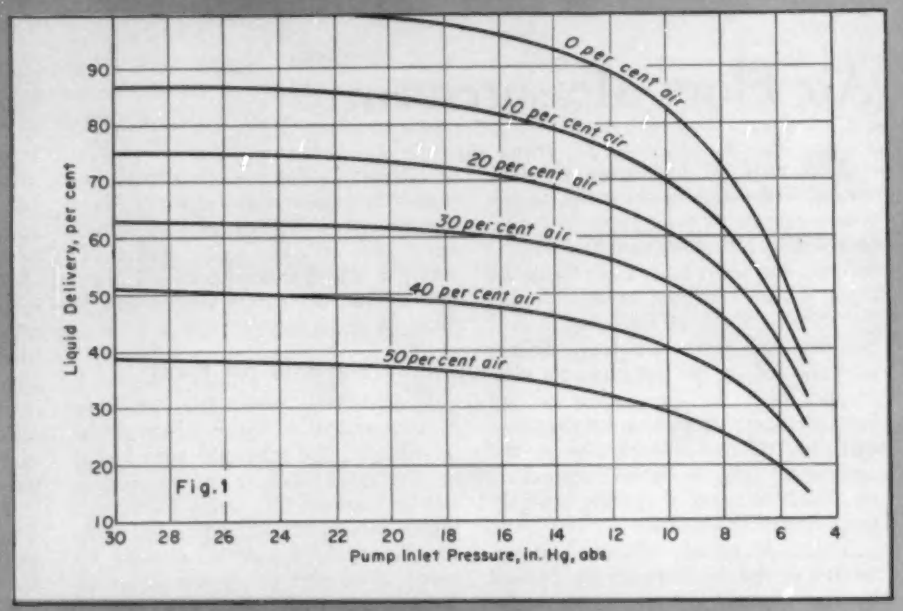

0 per cent air
10 per cent air
20 per cent air
30 per cent air
40 per cent air
50 per cent air
Liquid Delivery, per cent
Pump Inlet Pressure, in. Hg, abs
Fig. 1

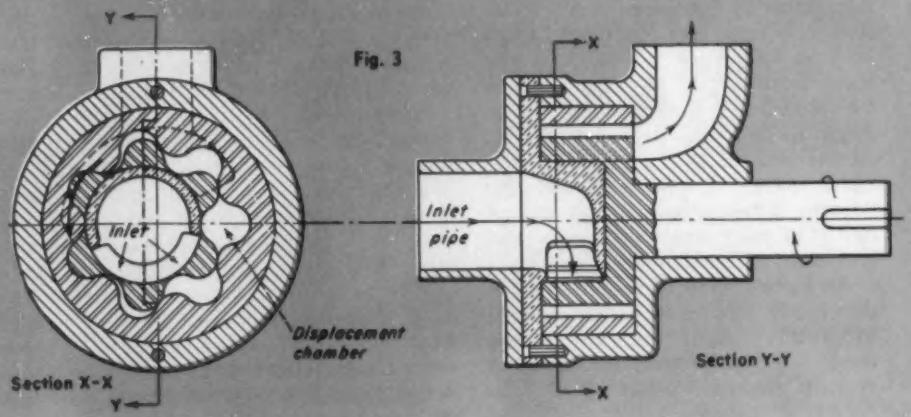
Fig. 1—For a positive displacement pump, delivery rate decreases as shown as the amount of air entrained in the fluid increases. Fig. 3 shows a pump designed to minimize this effect.

Fig. 2—Evolution and expansion of dissolved gas as it enters a spur gear type pump.

Fig. 3—Low loss, internally ported pump reduces the effects of aeration. Oil enters through the center of the inside gear, reducing turbulence and centrifugal effects.

Fig. 4—Tank outlet oil vs pump discharge pressure for an aircraft engine scavenge pump.

Fig. 5—Effect of supply oil temperature on air entrainment.



Aeration in Lubrication and

Importance, causes and methods of avoiding aeration. As a system is presented, incorporating techniques and devices

B. R. WALSH
Gulf Research & Development Company

AERATION OF OIL is of importance in fluid system design since the presence of air contributes to: (1) loss of pump efficiency; (2) defective lubrication of bearings (cavitation erosion); (3) loss of oil by foam overflow; (4) reduced pressure in hydraulic and pressure lubrication systems; and (5) erroneous readings of sump oil level.

Full liquid delivery from a positive displacement pump cannot be expected if entrained air is present. The pump will deliver a volume of liquid reduced by the volume occupied by air. Also, collapse of air bubbles when subjected to pump discharge pressure causes objectionable noise and may erode pump parts.

Oil delivery characteristics of a typical spur gear pump are shown in Fig. 1 with various percentages of entrained air at pump inlet conditions plotted against pump inlet pressure. The reduction in liquid delivery is greater than the volume of air at the pump inlet since the air increases in volume as it enters the pumping members, the magnitude of increase depending upon the pressure reduction inside the pump.

Pressure reduction within the pump differs with each design. In a spur gear type, this reduction is a result of jet and friction losses of oil entering the tooth spaces, turbulent flow losses in the intake chamber, skin friction, and

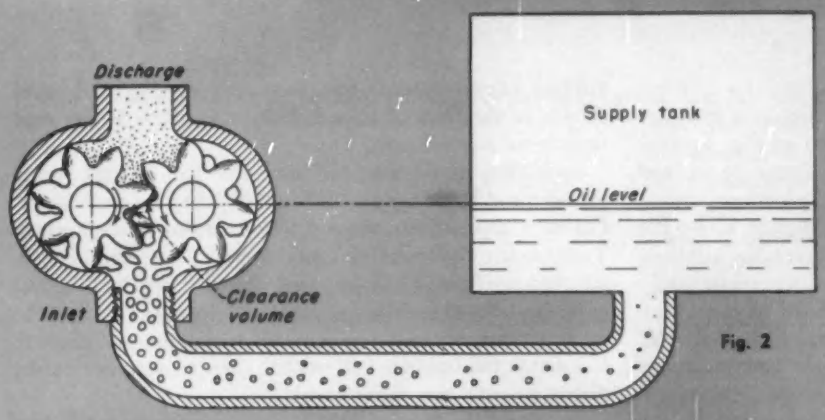


Fig. 2

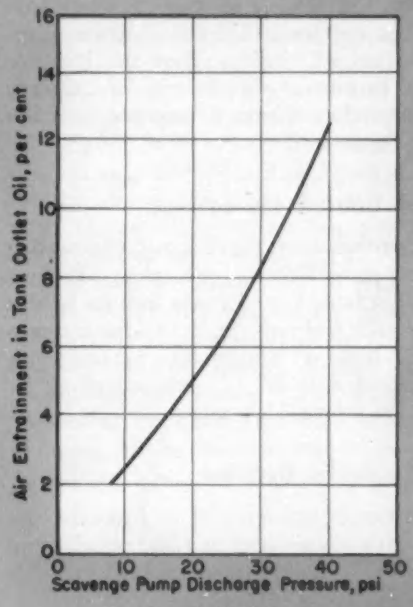


Fig. 4

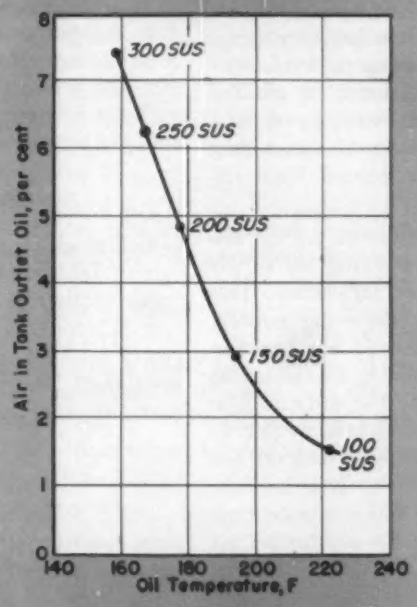


Fig. 5

Hydraulic Systems

guide to better circuit design, an ideal lubrication for minimizing aeration.

the centrifugal force of liquid in the tooth spaces.

The manner in which air bubbles expand as they approach and enter the pumping members is shown in Fig. 2. The collapse of these bubbles on the discharge side of the gears is also shown.

The clearance volume of the pumping members further reduces the pump capacity in the presence of entrained air. In a spur gear pump, this volume indicated on Fig. 2 is the volume trapped between two pairs of teeth at the instant of sealing from both suction and discharge. Because the air compresses when subjected to pump discharge pressure, the percentage of oil in the clearance volume is greater when returned to the pump inlet than it was under suction conditions.

In Fig. 3 is a pump designed for low internal loss. Oil enters through the center of the inside gear and consequently is not required to overcome centrifugal force in filling the tooth spaces. Tooth loss is reduced by providing tangential inlet ports between the teeth so that there is no sudden change in direction of oil flow entering the pump chamber. Methods for determining pump losses are given in *Product Engineering*, November 1946, pages 126-128.

Sources of air entrained in pump oil include: (1) excess capacity of scavenge pump in dry-sump systems; (2) splashing of oil in supply tank by the return system; (3) dissolved air in oil; and (4) air leaks in pump inlet line.

In dry-sump systems using a scavenge pump, capacity of this pump is usually larger than the main supply pump. As a result, the scavenge pump sucks air which becomes distributed throughout the oil. Discharge pressure of a positive displacement scavenge pump determines the size and separation characteristics of air bubbles in oil; this pressure, in turn, depends upon the size and resistance of tubing and apparatus, such as coolers and filters, installed in the discharge line. Fig. 4 shows how air in tank-outlet oil can vary with scavenge pump discharge-pressure and indicates that scavenge pump discharge-pressure should be as low as practicable. Fig. 5 shows that air entrainment in outlet oil increases as the tank-temperature increases. In this instance, the flow is laminar and bubble rise is an inverse function of viscosity. In the event of some turbulence in the tank, a change of viscosity with increased temperature has less effect on air separation since bubble rise is independent of viscosity in turbulent flow.

Installing oil coolers between the tank and supply pump instead of between the scavenge pump and tank will reduce air entrainment by increasing the temperature of oil in the tank and also will reduce scavenge pump pressure. This arrangement will result in tank-oil temperatures ap-

proximately equal to engine oil temperatures.

One method for reducing free-air handled by a scavenge system uses two separate pumps as shown in Fig. 6. One pump has a capacity only slightly in excess of normal engine flow, and the other provides the additional excess capacity for scavenging and has its inlet slightly above the normal sump level. The latter pump, normally handling air, has its discharge connected to that of the main pump through a check valve. An air bleed, ahead of the check valve, is connected with the sump so that if the oil level rises in the sump, the auxiliary scavenge pump primes itself and builds up enough pressure to open the check valve and deliver oil to the tank. The oil flow rate to the sump through the bleed hole is negligible.

Other methods for reducing free-air handled by scavenge pumps involve means for maintaining sump oil level above pump inlet. This can be accomplished either by controlling pump speed or through by-passing scavenge oil back to the sump. One scheme for by-passing oil uses a float controlled by-pass valve, while others depend upon hydraulic control.

In any event where liquid is recirculated, air entrainment may be decreased if the stream entering the supply tank is introduced to avoid splashing and turbulence. This can often be accomplished simply by designing smooth, submerged return systems. In some cases it may be desirable to install baffles between the incoming and outgoing liquid to assist air bubbles in rising to the surface. The time the liquid remains in the supply tank is important to permit escape of entrained air. For example, tests on several cylindrical aircraft type tanks with oil at a viscosity of 180 SUS and 185 F, Fig. 7, show that residence time should not be less than two minutes for satisfactory air separation. For more viscous liquids, the time should be increased. Also, the distance air bubbles travel to reach a free surface should be kept to a minimum.

Liquids in contact with air contain air in solution. The weight of air will dissolve in proportion to absolute pressure, the dissolved volume measured at any saturation pressure being constant. For example, under equilibrium conditions, a lubricating oil will have in solution about 0.09 cu ft of air per cu ft of oil (*Journal of the Institute of Petroleum*, Vol. 38, 1952, pages 483 and 490). Since this air will come out of solution when pressure is reduced, as occurs in a pump inlet system, it will appear in the form of entrained bubbles which will reduce the pump capacity.

Where high suction is encountered, sources of air leaks such as loose pipe connections, filter caps, pump shaft packing and external pressure regulating valves should be avoided.

Deaerators

Deaerating devices are sometimes used to remove entrained air. Numerous types have been tested, some of which rely upon the velocity of entering oil to provide sufficient centrifugal force for air separation. Usually, at least 3 G are necessary for satisfactory performance.

Indications are that the efficiency of deaerators in air separation depends largely upon the type of air-oil mixture being circulated. For example, where the incoming mixture had been subjected to high pump pressure, only 5 per cent separation was obtained, whereas when the incoming mixture was subjected to low pressure most of the entrained air was in the form of large bubbles and 90 to 95 per cent separation was obtained.

As a rule, air-oil mixtures are subjected to high pump pressure and static type deaerators generally are inadequate. For such applications power-driven deaerators are required. Tests on five power-driven units showed deaerating efficiencies varying from 70-75 per cent. Most deaerators depend upon centrifugal force for separation, although Fig. 8 shows an apparatus wherein a vacuum is applied to the mixture to enlarge the bubbles and permit their coalescence before discharge into the supply tank.

It cannot be assumed that a deaerator which is efficient in one flow system will be good in another. Tests indicate that an optimum size unit exists for any application, depending upon flow rate, oil viscosity, dispersion (bubble size and pressure). Because of the decrease of efficiency with oil pressure, deaerators should be installed in a low pressure section of the system.

Ideal Lubrication System

For minimum air entrainment, Fig. 9 shows a lubrication system incorporating the following principles: (1) long residence time of oil in tank; (2) short distance for bubble rise; (3) minimum splash and turbulence; (4) low scavenge pump pressure; (5) high oil temperature in tank; (6) minimized admission of free air; (7) removal of air by deaerator; and (8) low internal loss pump.

Hydraulic Systems

Pump difficulties can be encountered in hydraulic systems operating at high pressures such as 1,200 psi gage and having a surge chamber with air in direct contact with the oil surface.

For example, if oil is exhausted to atmospheric pressure after passing through work cylinders or hydraulic motors, all of the dissolved air can came out of solution except 0.09 cu ft corresponding to saturation at atmospheric pressure. This volume of released air measured at atmospheric

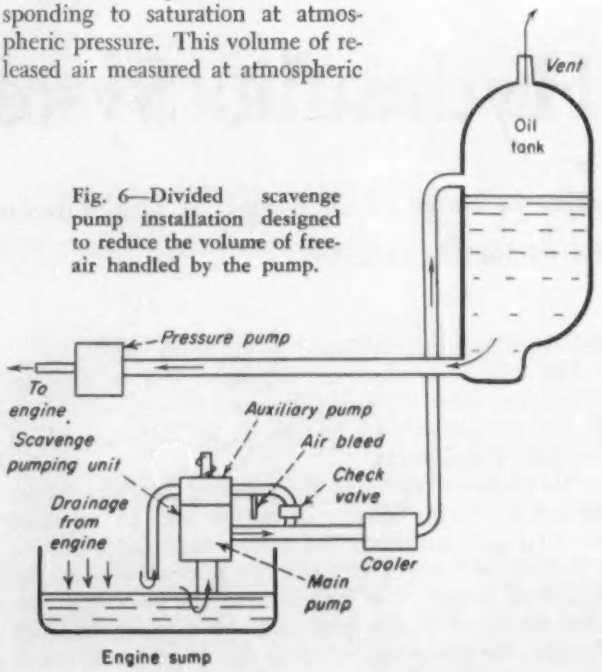


Fig. 6—Divided scavenge pump installation designed to reduce the volume of free-air handled by the pump.

pressure can amount to approximately 7.3 cu ft per cu ft of oil:

$$\frac{0.09 \times 1214.7 \text{ psia}}{14.7 \text{ psia}} - 0.09 = 7.3$$

This condition can and does give trouble in hydraulic systems. For example, the compressibility of air may set up surging conditions in the system.

Aeration in Engine Bearings

Lubricant supply for connecting rod and wrist pin bearings in a Diesel or high-speed reciprocating engine can be affected by accelerating and decelerating forces acting on the column of oil within a drilled connecting rod. When an engine is operated at high speed, deceleration of the rod can be of such magnitude on the upper half of the upstroke that oil will be forced through the wrist pin bearing at a rate in excess of supply to the crank-pin bearing. Under this condition, air will be sucked into the crank-pin bearing to make up the volume deficit, thereby interrupting the lubricating oil film.

On the return stroke the reverse is true; that is, forces on the lubricant remaining in the rod hole can retard flow into the crank-pin bearing. Besides resulting in premature lubrication failure, such cyclic oil flow can be a factor in promoting cavitation erosion. During such erosion, sections of bearing material are removed by a hammering action which is a result of the rapid collapse of air bubbles in the lubricant. If the lubricant supplied to the rod is used for piston cooling, which is generally the case for Diesel engines, inadequate piston cooling may also result. To overcome these difficulties, it may be necessary to supply the engine with an oil pump of greater capacity or reduce pump requirements. For example, a separate pump and piping system could be used for piston cooling of Diesel engines.

In splash systems while the oil level must be high enough to permit suitable splashing of oil for lubrication of cylinder walls and bearings, it must not be so high that aeration can cause erroneous readings of sump oil level, which should preferably be taken when the machine is idle.

Since aeration seems to be largely a question of construction and operation of a lubricating oil system, every reasonable design precaution should be taken to avoid any chance for entrance of air to occur.

Antifoam Agents

The elimination of foam is desirable to reduce aeration in some fluid systems and for reducing oil loss by foam overflow. In those instances where foaming occurs, even with good mechanical design, a good foam-suppressing agent can be used for eliminating or reducing foam. Such agents are selected to control foam without interfering with the functional properties of the lubricant.

It should not be assumed that use of an antifoam agent will necessarily solve all aeration difficulties. It has been noted that while total volume of air entrained in an oil containing an antifoam agent was reduced, a pump with its inlets submerged near one end of a supply tank actually withdrew a larger volume of air. This can occur because, while antifoam agents promote coalescence of air bubbles of moderate size to form larger bubbles which escape more rapidly to a free surface, the rate of release of very small air bubbles is sometimes retarded.

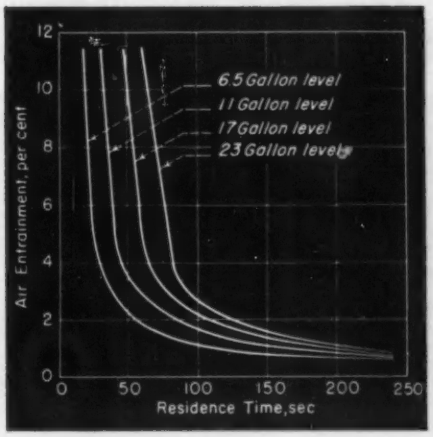


Fig. 7

Fig. 7—Variation of air entrainment with residence time for a typical aircraft engine oil system.

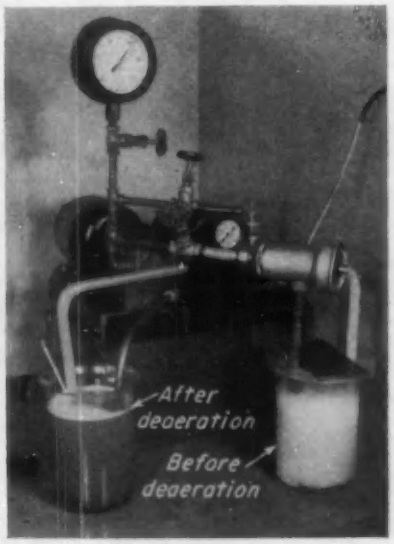


Fig. 8

Fig. 8—Container at right contains air-oil mixture. After passing through the apparatus, oil is deaerated as shown by container at left.

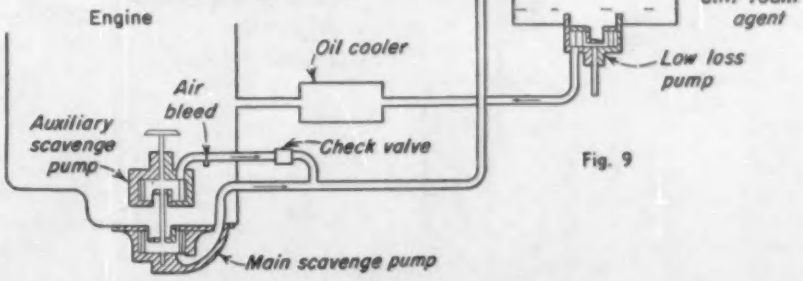


Fig. 9

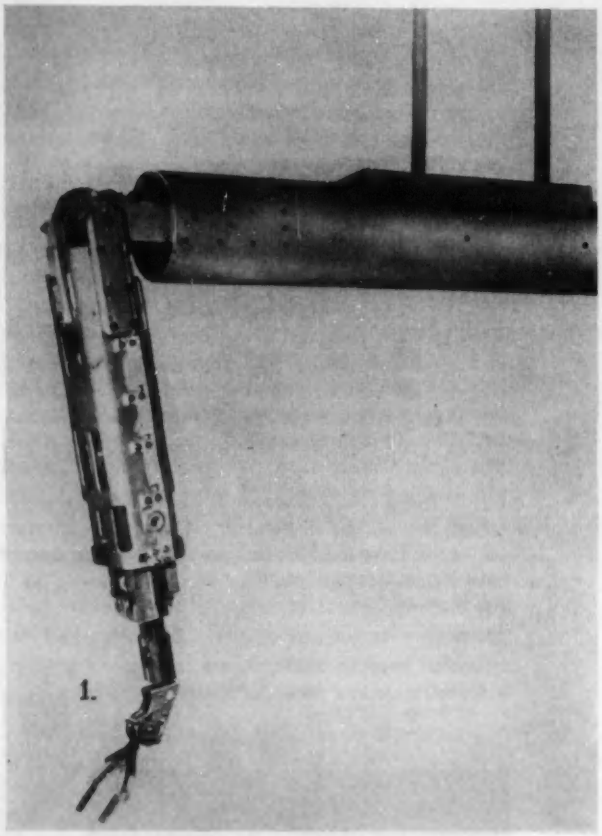
Fig. 9—Composite lubrication system for minimum air entrainment.

DESIGN FEATURES

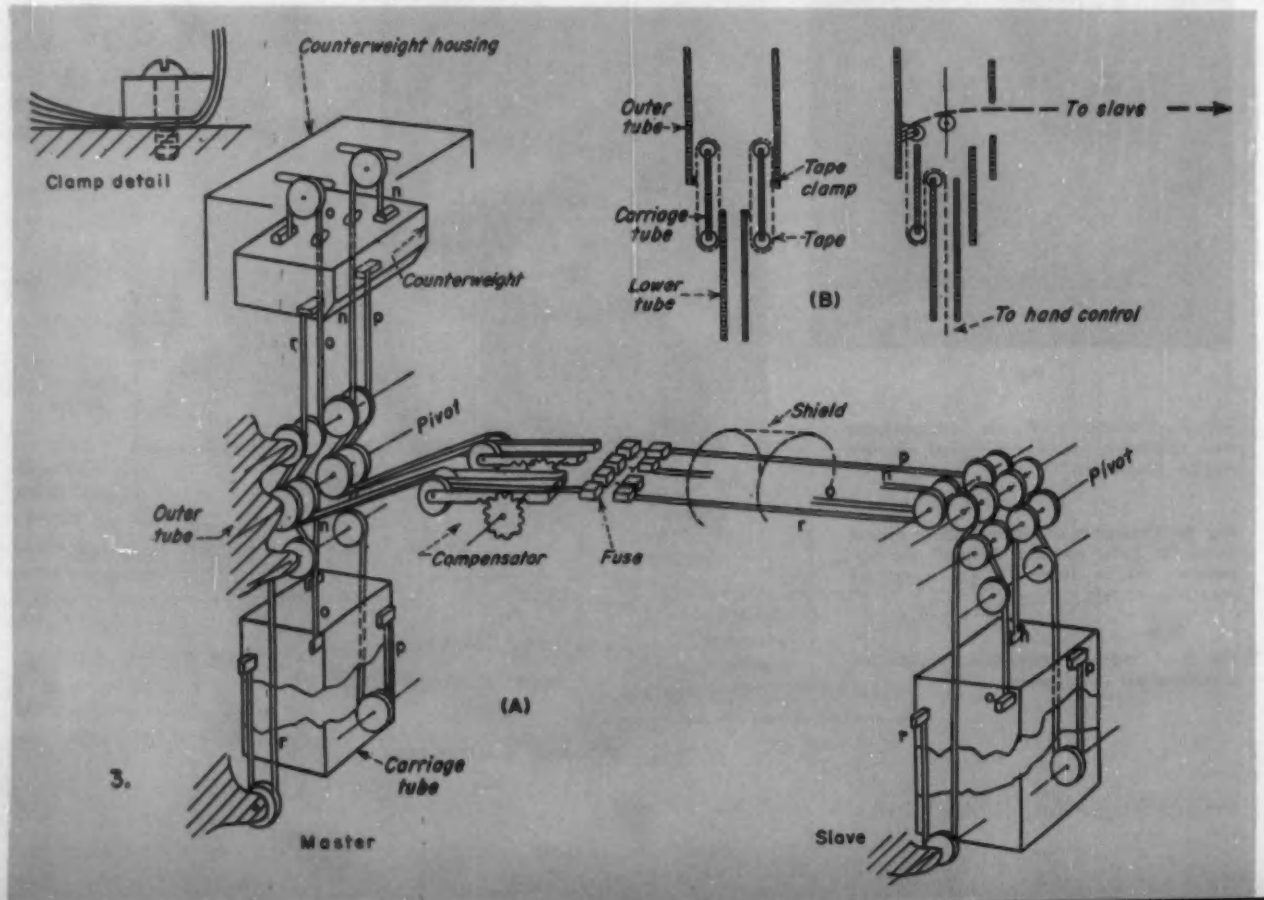
Extra-Maneuverable Manipulator

A plug-in type of master-slave manipulator for use in hot-cell operation was desired for 1) effective utilization of unit between two or more cells; 2) facilitation of economical cell construction; 3) added safety insurance for operator. A manipulator developed by the Alderson Research Laboratories, Inc., New York, N. Y., for the Knolls Atomic Power Laboratory, Schenectady, N. Y., meets all three specifications.

The manipulator has no slave-side counterweight, and the slave-arm may be tilted to a position coaxial with the thru-wall tube. The counterweight moment-arm on the master side equals the combined moment-arms of the master and slave telescopic sections, keeping the system of forces in balance through all operating motions. A tape-tensioner mechanism, using an idler pulley and spring-loaded gear arrangement to compensate for varying tape length, makes possible a non-parallel relationship between the master and slave arms. The slave arm tilted 90 deg to the vertical, with no overhead projection, is easily slipped through a port-hole.

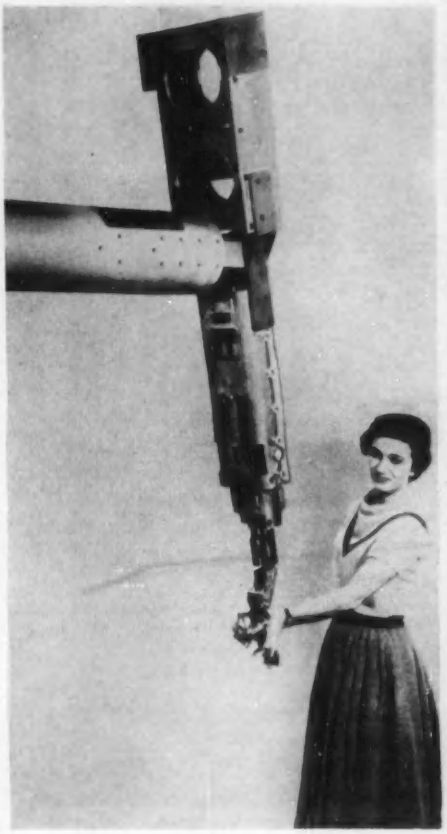


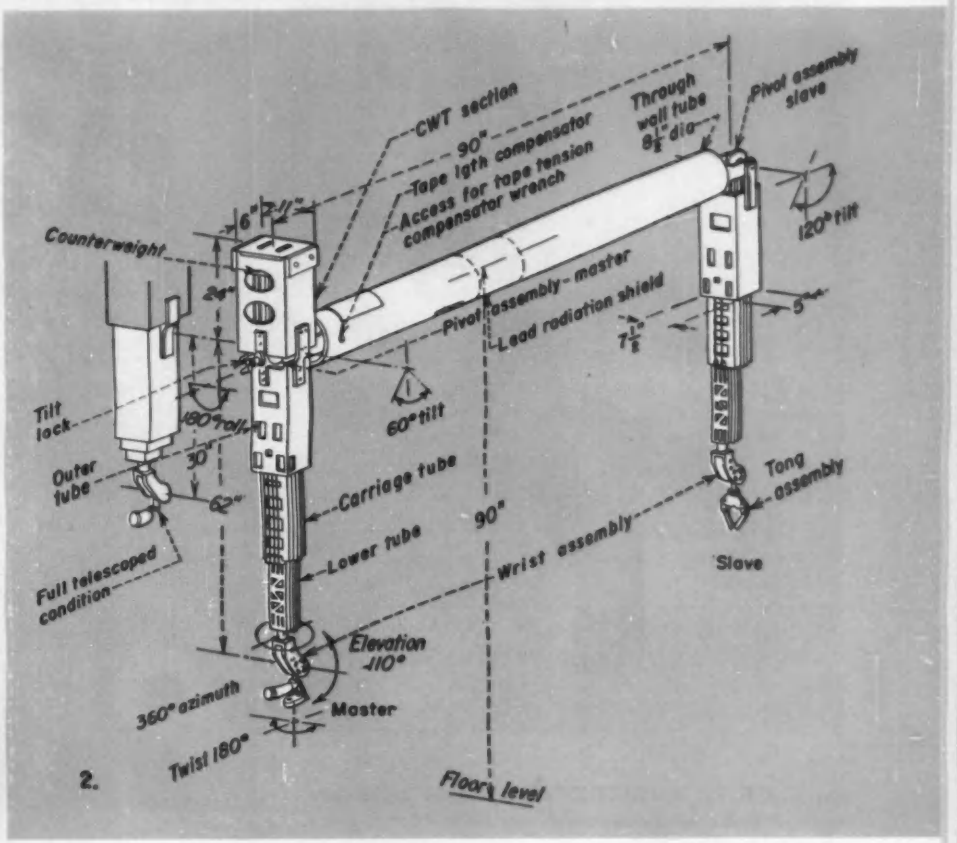
1.



3.

IN NEW PRODUCTS



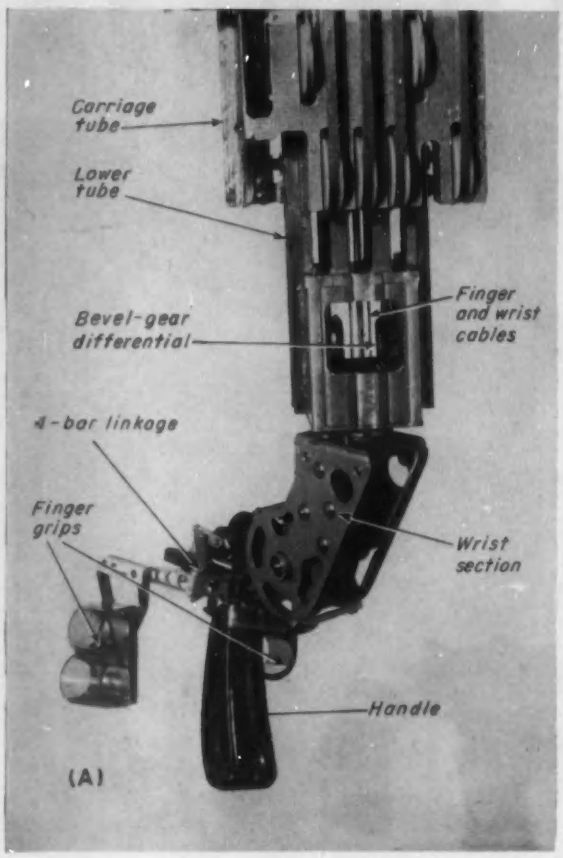


1. Basic configuration of manipulator. Head room required on master side is less than 10 ft and on slave side less than 8 ft. Short height requirement makes possible more economical cell-construction. The thru-wall tube is fabricated of tin-plated seamless steel tubing, telescopic tubes made of aluminum castings. Accessibility is furnished by door above tensioner-unit and telescopic tube cutouts adjacent to tape fuses. Center of thru-wall tube is shielded against radiation by a lead-filled 10-in. long cylinder. The manipulator has a 10-lb load rating.

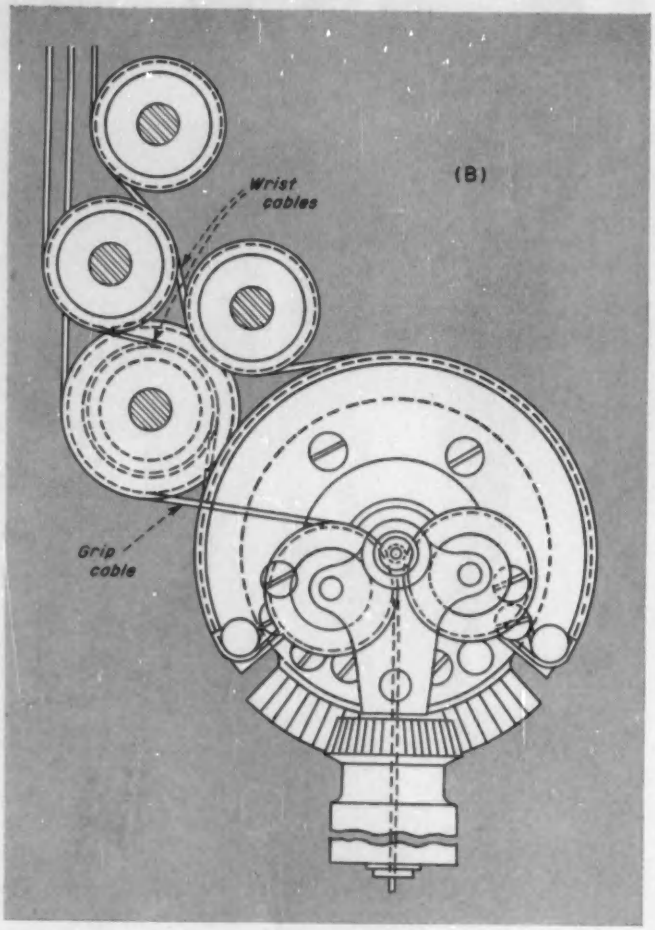
2. Overall dimensions and operating range. Mounted on radial bearings in the thru-wall port-hole, the unit may be rotated to any position about the horizontal axis. Gravity limits the effective rotation to a 180-deg arc; a 60-deg angle from the vertical is seldom exceeded for operation requirements. All motion is transmitted by means of closed loops, pre-tensioned to eliminate backlash and play, and providing sensitivity; only the tongs are spring-opening. Cobenium tapes are used except in region of twist between finger and wrist transmission paths. In twist region, extra-flexible stainless steel cables are used. All tapes and cables are doubled to minimize stretch under load; space limitation on size of pulleys prevents use of tapes and cables of heavier cross-section. All pulleys are nylon-molded on knurled aluminum hubs; nylon was chosen for mechanical strength, low friction and dimensional stability.

3. (A) The counterweight serves both the master and slave arms, maintaining the total system in balance about all axes. Counterweight is equal to twice a carriage tube weight plus four times the weight of a lower tube with wrist and hand attachments. Direct link between counterweight and carriage tube makes possible normal range of telescopic motion with shorter counterweight travel. On vertical movement of carriage tube, counterweight moves an equal and opposite distance. Carriage tube motion on master side is duplicated on slave side by tape-pulley system shown. Tensioner unit and all tape fuses are located on master-side for ready access. (B) Tube cross-section and tape systems. A secondary tape system, as shown at left, equally divides telescopic motion between carriage tube and lower tube. Tape length of the hand-control pulley system, shown on right, remains the same throughout range of telescopic motion. Unit is particularly adaptable to multi-cell operation. Conventional manipulator utilized counterweight on slave-side; resulting projection preventer easy removal and installation. Moreover, the conventional unit was not suitable for non-parallel arm operation, the additional factor in quick inter-cell transfer. Elimination of projection reduces height requirements, preparing way for more compact cells. Thus, lower cost construction is possible. The operator is less subject to radiation exposure, as the slave-side assembly can be slipped through port-hole without need of operator in hot cell. Previous units required operator in cell to manually position the slave assembly during installation and removal.

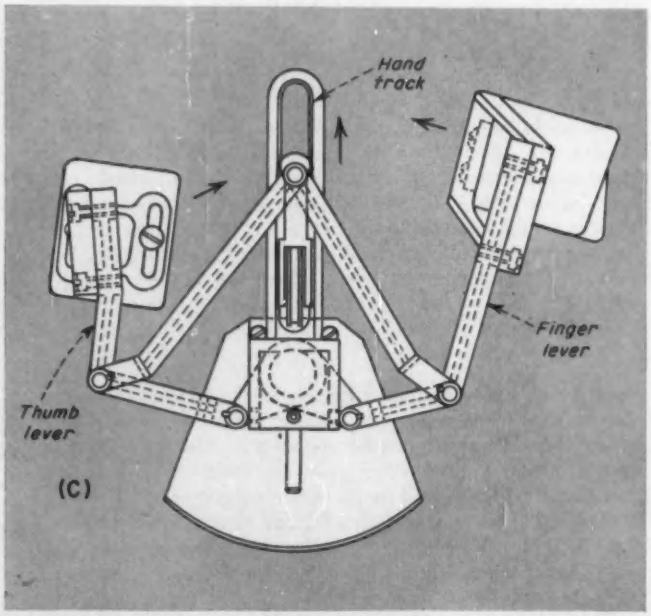
(continued on next page)



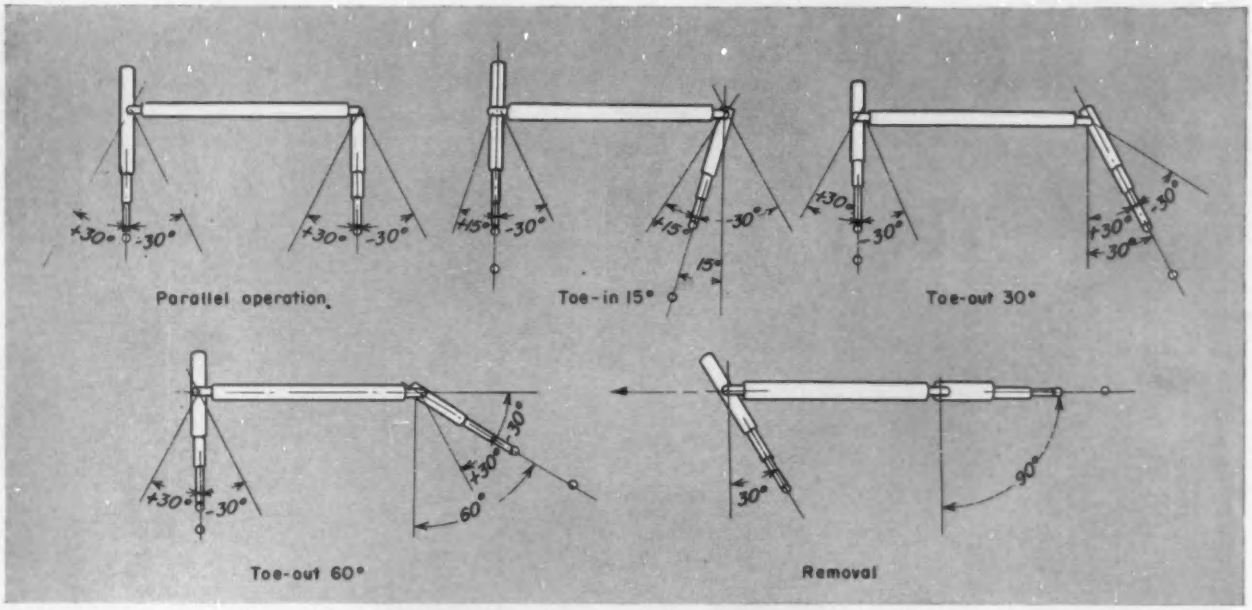
(A) **AZIMUTH ROTATION** is effected by radial movement of shown handle and wrist assemblies. Motion is conveyed by bevel-gear differential in lower tube translating the axis of rotary movement to tape-attached drum. Pulley arrangement duplicates motion on slave side through second bevel-gear differential. Wrist twist is produced by radial movement of the handle assembly only. Elevation of handle assembly is varied by means of rocking-like motion in the longitudinal plane.



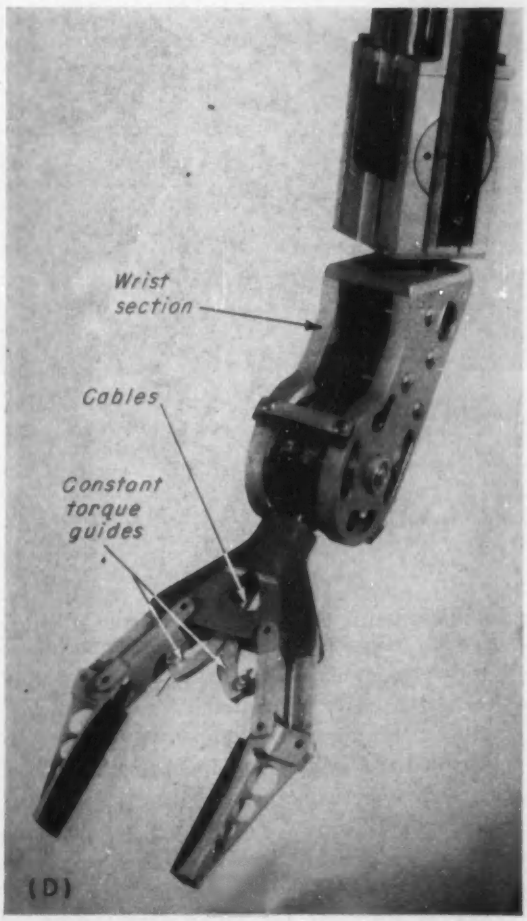
(B) Wrist twist and elevation of handle assembly are separately transmitted by a bevel-gear differential in the wrist assembly as shown. The handle is mounted on pinion of differential. Twist is transmitted by bevel-gear differential translating the axis of rotary motion to tape-wound drum; elevation is accomplished by rotating gear assembly about the horizontal axis, the three gears fixed relative to one another. Mechanical stops limit wrist twist to 180-deg arc and elevation to 110-deg range. The 360-deg azimuth rotation twist wrist and finger cables—full twist occurring in lower tube. Thus, cables are placed close to center of vertical axis of tube with finger cable directly on axis, to keep cable stretch below elastic limit. A brass tube in the region of extreme twist separates the cables and minimizes friction.



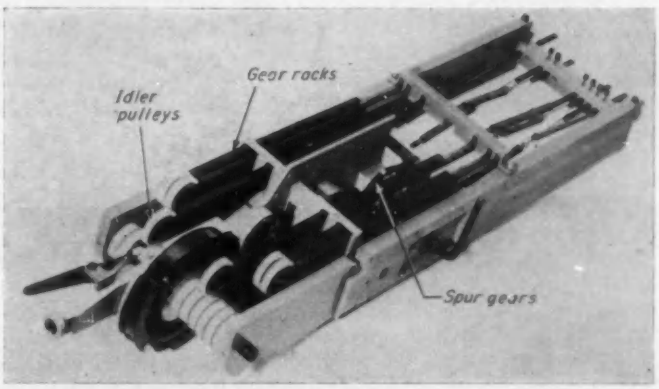
(C) **GRASP.** Finger grips are used to actuate a four-bar linkage. Tong fingers are held normally open by a torsion spring, keeping grips apart. Pressure on grips moves groove-arm outward, putting finger cable in tension to close tong assembly. Groove assures that equal force will be applied to opposing tong fingers.



NON-PARALLEL ARM OPERATION. An extended operating range facilitates in the handling of cell materials; easier control is obtained over objects close to or at far distance from thru-wall. Master and slave arms can operate in non-parallel modes from 15 deg. toe-in to 60 deg toe-out. The master-arm assembly is disengaged from main roller in pivot section and moved to desired tilt angle. Re-locked to drum, the master arm is swung back to vertical plane, simultaneously moving slave arm to set tilt angle. To horizontally position slave arm, two 30-deg toe-out adjustments are necessary.



(D) LOWER SECTION of slave arm with tong assembly. Cable pull produced by grip action on master side closes tong fingers. Cable guides shown maintain constant radius path, to keep torque exerted by opposing elements equal.



AS MASTER AND SLAVE ARMS are moved into a non-parallel relationship, an automatic tensioner unit compensates for altered tape-path lengths and preserves optimum tape pre-tension. The mechanism consists of a set of idler pulleys mounted against gear racks; in mesh with each gear rack is a spur gear driven by a non-linear spring linkage. The unit is crank-operated. During operation of the manipulator, the crank locks the gears, eliminating spring action and maintaining correct tape tension. In tilt adjustment, the gears are released. Idler pulleys act to maintain proper tape tension. At new operating position, gears are re-locked. During assembly of the manipulator, the springs are set to provide medium friction tension. Any stretch that later develops is taken up my momentarily unlocking the tensioner, allowing the springs to act. Several tapes by-pass the tensioner unit. Tilt tapes which do not change length are adjusted by turn-buckles. Tapes which relate telescopic tube motions are non-critical in tension and kept taut by means of anchor clamps.

FASTENED TO TRACTOR by four bolts, the mower is self-contained except for pump. The pump is driven directly off of engine crankshaft. Tank unit carries valve and control levers, carriage and operating cylinders. Breakaway, motor drive and cutterbar are secured to carriage by means of trunnion pin. Positive transport locks are built-in; two pins lock cutterbar in vertical position, obviating rods and chains. Mower is of unit-type welded construction.

High-Speed Low-Upkeep Mower

Expanding construction programs and increased mowing costs per mile have created a demand for an efficient highway mower. The Hydro-Clipper, a mowing unit developed by the Triumph Machinery Co., Hackettstown, N. J., provides low-cost maintenance with high cutting speed. Easier operator control and compact, functional assembly characterize design.

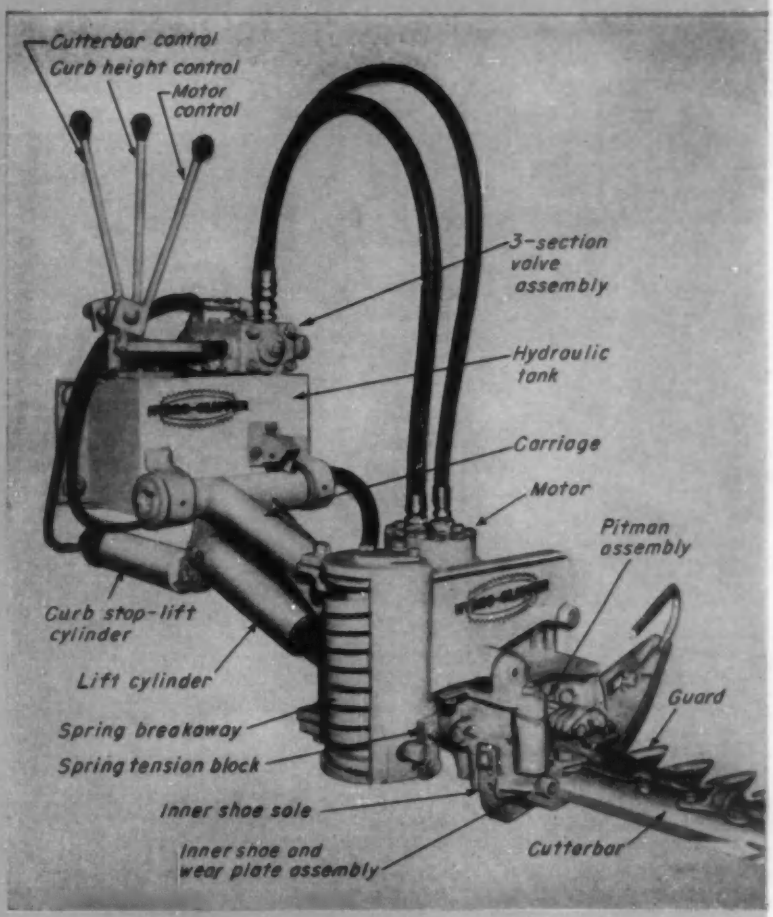
Several elements contribute to low-cost upkeep. The hydraulic system has fifty per cent less parts than a mechanical drive, reducing the weight in motion behind knife by two-thirds. Instant pressure release for an overloaded cutterbar is furnished by a relief valve. Raising the carriage pivot point reduces possibility of damage inside the breakaway.

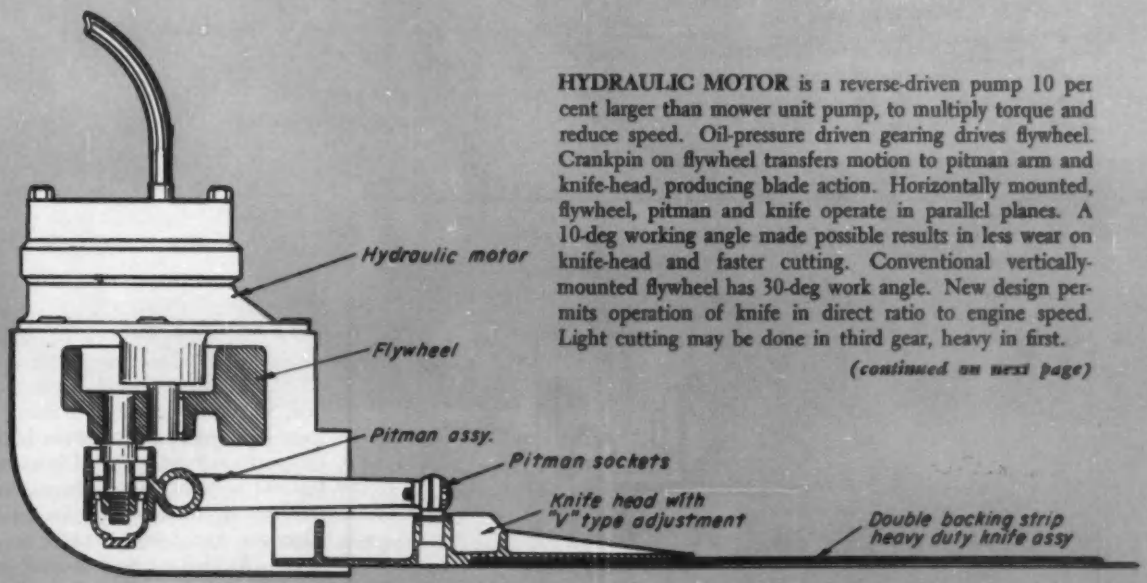
A horizontal flywheel operates in a plane parallel to pitman drive and knife, shortening the pitman working angle to 10 deg. High-speed cutting is furthered by use of a high-torque motor in a simplified hydraulic circuit.

Easier control is mainly attributable to the spring-loaded cutterbar. Clutching is eliminated; 90-deg self-return is provided and lead-angle adjustment facilitated. Bobbing is reduced by balanced cutterbar construction, and dash-pot action of control-cylinders. A v-type knife-head introduced on the unit provides more wear area than previous knife-head, to give longer life.

The mower is adaptable for loader combination, as both mower and loader can operate from a single pump. No hoses or switch valves are needed in the change of the two tools. Adaptability is made possible by high-pressure carryover valve design.

THREE CONTROL LEVERS operate the unit. Cutterbar lever raises the bar, preventing knife action until bar is re-lowered into mowing position. A second lever adjusts curb height of inner shoe over 15-in. range. The cutterbar can be set to "float" for average mowing or made to "hold" for topping. Third lever regulates motor-driven knife, permitting a constant-running cutter-bar. Need for special tractor clutch for live power take-off is eliminated. Pivot of carriage is 10 in. above that of most conventional models. With pivot point almost a foot above ground, cutterbar can float over many obstructions striking inside the breakaway. The torsion spring assures automatic return of cutterbar to operating position. An adjustable lead-angle, set by means of a forward stop, is made possible by spring-action. The all-hydraulic drive eliminates vee-belts, universal joints and other parts found in a mechanical drive. While conventional mechanical drive has about 100 lb of weight in motion behind knife, hydraulic drive has less than 30. On abrupt stops, chance of section failure is reduced. To unload knife against resisting object, slippage usually occurs in the mechanical system. In hydraulic system a valve automatically relieves pressure, protecting against guard and section damage.



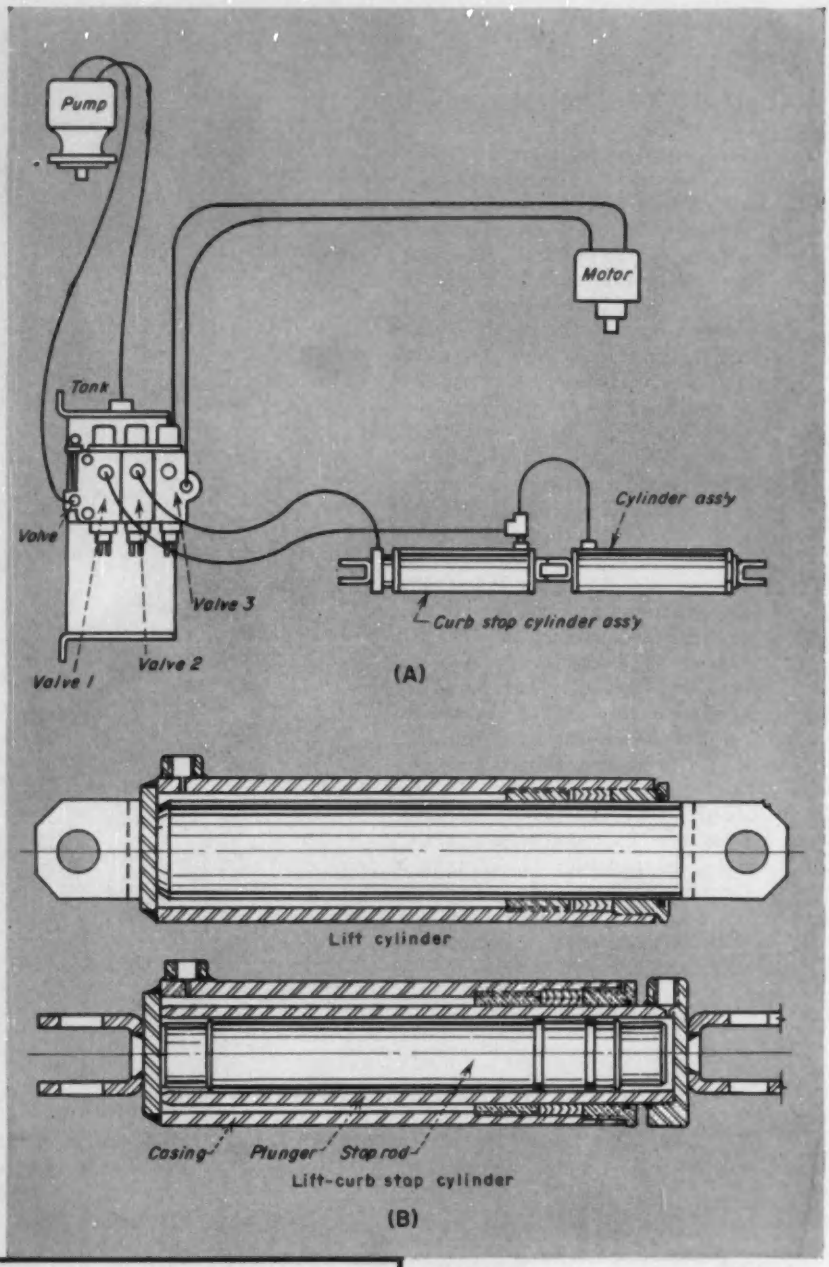


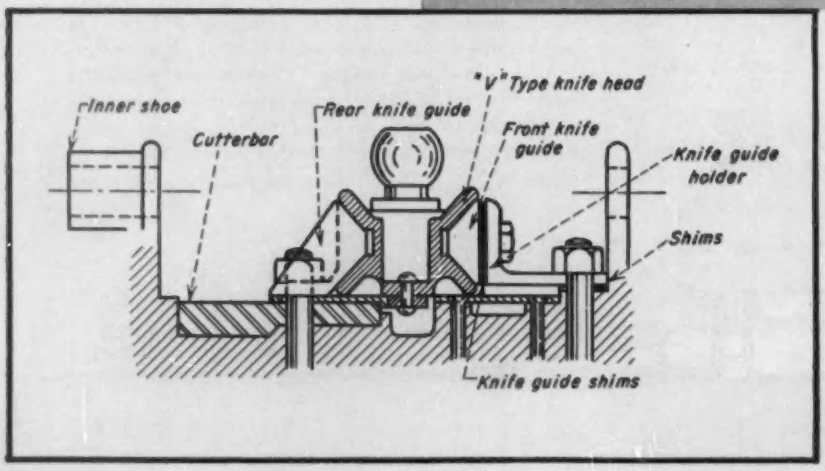
HYDRAULIC MOTOR is a reverse-driven pump 10 per cent larger than mower unit pump, to multiply torque and reduce speed. Oil-pressure driven gearing drives flywheel. Crankpin on flywheel transfers motion to pitman arm and knife-head, producing blade action. Horizontally mounted, flywheel, pitman and knife operate in parallel planes. A 10-deg working angle made possible results in less wear on knife-head and faster cutting. Conventional vertically-mounted flywheel has 30-deg work angle. New design permits operation of knife in direct ratio to engine speed. Light cutting may be done in third gear, heavy in first.

(continued on next page)

(A) SEALED HYDRAULIC SYSTEM has reduced number of hose-lines and fittings, to minimize oil friction. System temperature under normal operating conditions is about 40 deg above air temperature. Operating on a 10-qt capacity, displacement is at rate of 7½ gal/min at 1200 rpm and 1000 psi. Each cylinder has lifting force of over one ton. Pump forces fluid into first section of valve assembly, by-passing relief valve. The relief valve opens to allow fluid return to tank if oil passage is blocked. The three valve sections operate in series. Valve 1 opens to let oil into two lift cylinders. No oil can flow to valves 2 and 3 while valve 1 is open. With valve 1 in neutral, and valve 2 open, oil is pumped into curb-stop cylinder to set height of inner shoe. Overflow from valve 2 enters valve 3, making possible continuous operation of cutterbar. With valves 1 and 2 in neutral and valve 3 open, oil is pumped to hydraulic motor. Dash-pot action of cylinders lessens cutterbar bobbing over ground contours; small diameter hose lines resist oil back-flow.

(B) TWO SINGLE-ACTING CYLINDERS, simple and trouble-force, provide the hydraulic lift. Oil is pumped through inlet of upper-shown cylinder to force plunger out of casing. Simultaneously, oil flows into right-hand inlet of lower-shown cylinder; pressure on plunger pushes plunger and stop-rod together. To set curb height, oil is pumped into left-hand inlet of lower-shown cylinder, to push out stop rod. Plunger position stays set during lift and lower operations.

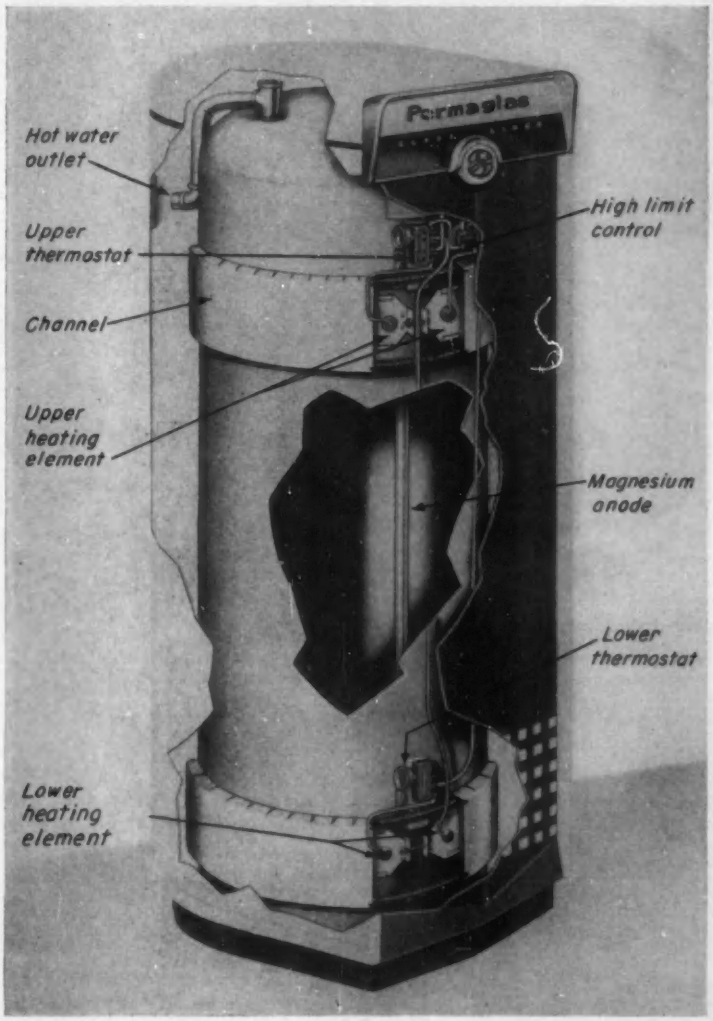




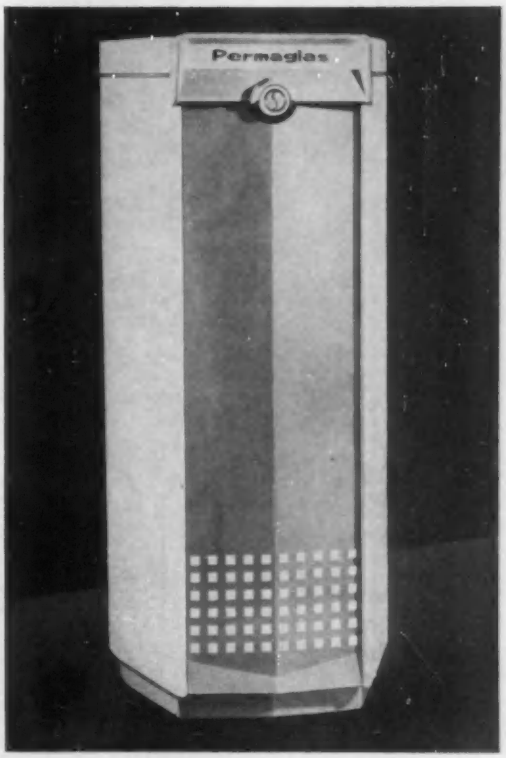
V-TYPE KNIFE-HEAD as shown provides six times the wearing surface of previous head. Four machined plates make contact at four different angles; in addition, a longer wear block is used. Single-point adjustment of knife-head is made at shims. Knife-head is guided front and rear, top and bottom. The knife cuts on same principle as shears. Two hardened steel edges are forced into contact by ground level. Double-backing knife-strip reduces possibility of shearing rivets or loose sections. Guard pitch can be lock-adjusted through ±7 deg range.

Low Cost, Long Life Heating Unit

A new electric water heater manufactured by A. O. Smith Corp., Milwaukee, Wis., has heating element with low heat-dissipation per unit area; the flexible belt-like element is wrapped around tank for easy installation and replacement. Exterior of heater unit has contour and color design, suitable for kitchen installation, reducing plumbing and fuel costs.

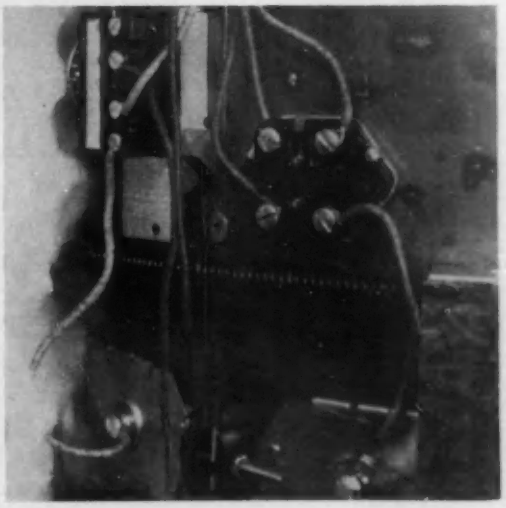


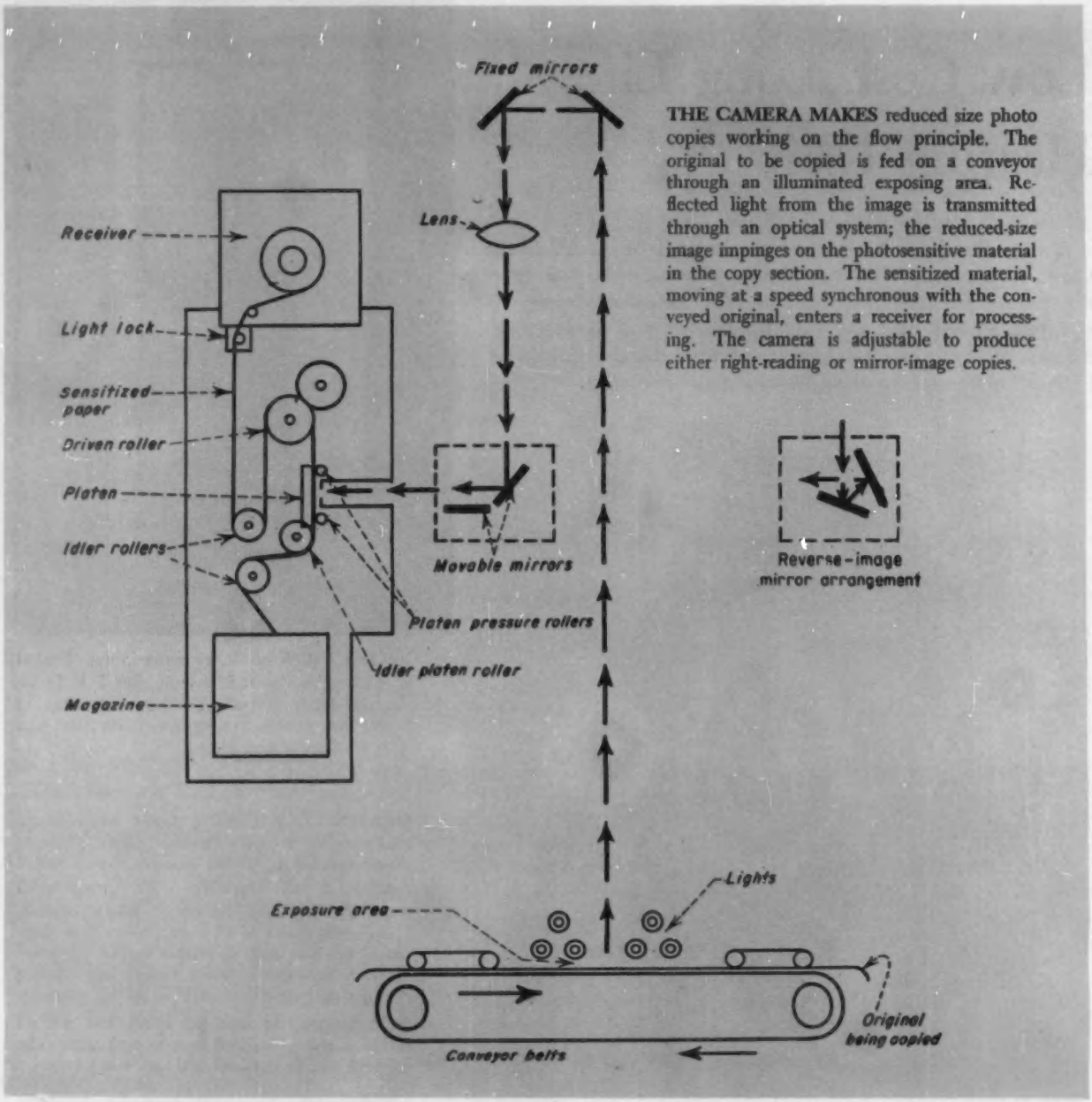
HEATING IS CONTROLLED by two separate adjustable thermostats holding water temperatures to a differential of 5 F. Lower thermostat control is for incoming cold water. Upper control maintains desired water temperature. An additional high-limit control cuts off current to heating element, should thermostats fail and water overheat. Thermostats may be wired to provide independent or synchronous operation. Interior glass-lining protects against destructive electrolytic action, and is supplemented by a magnesium anode. Built-in junction-box at rear of unit houses leads to thermostats and high-limit control.



FRONT VIEW of electric water heater. Largest unit of series stands 5 ft 8 in., has 2 ft 1½ in. dia and holds 80 gal. Kitchen installation of heater near utilities and appliances shortens pipe lines to thereby save fuel.

HEATING ELEMENT is slipped into channel, and wrapped around cylindrical tank. Made of aluminum-clad steel the element has notched flanges for full flexibility. Two springs with clamp fixtures keep element in proper tension. Large surface area of element reduces heat dissipation per unit area, to protect against the possibility of burn-out. Former tubular-type heating element dissipated 65 watts per sq in.; new element dissipates 15 watts per sq in. The channel serves to reflect radiated heat to tank wall. The element can be replaced with screw driver.

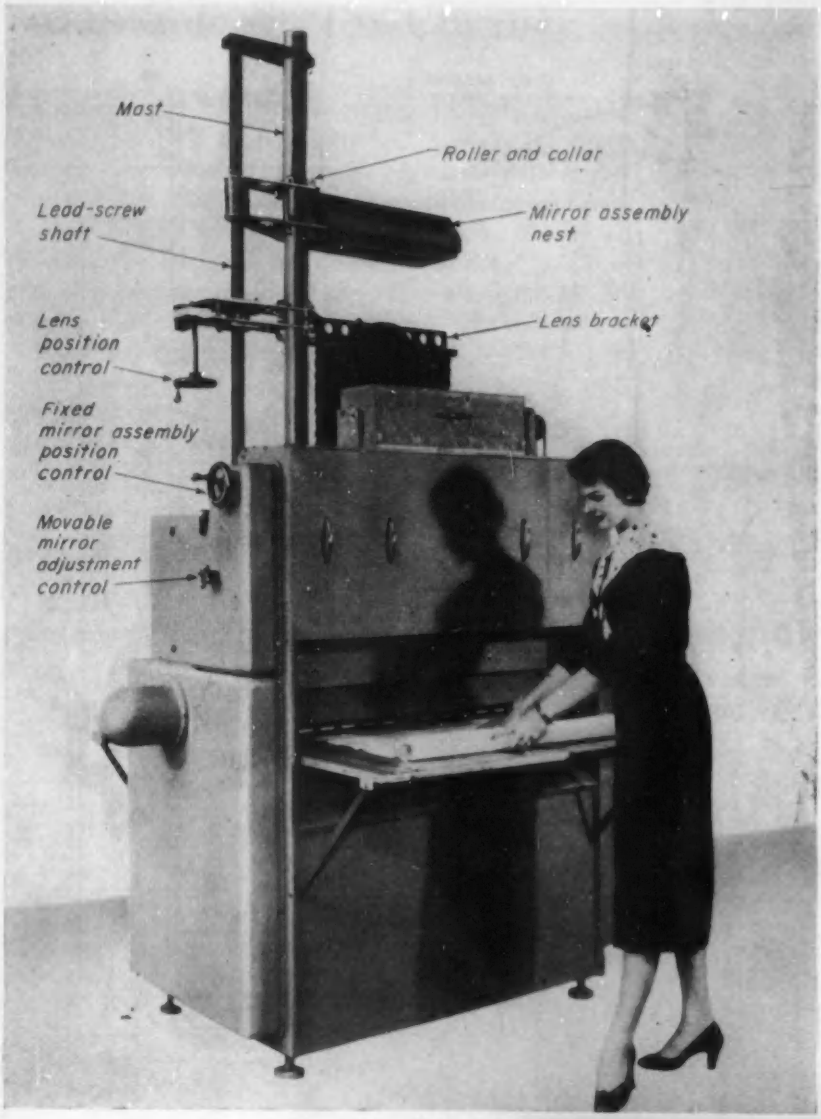




THE CAMERA MAKES reduced size photo copies working on the flow principle. The original to be copied is fed on a conveyor through an illuminated exposing area. Reflected light from the image is transmitted through an optical system; the reduced-size image impinges on the photosensitive material in the copy section. The sensitized material, moving at a speed synchronous with the conveyed original, enters a receiver for processing. The camera is adjustable to produce either right-reading or mirror-image copies.

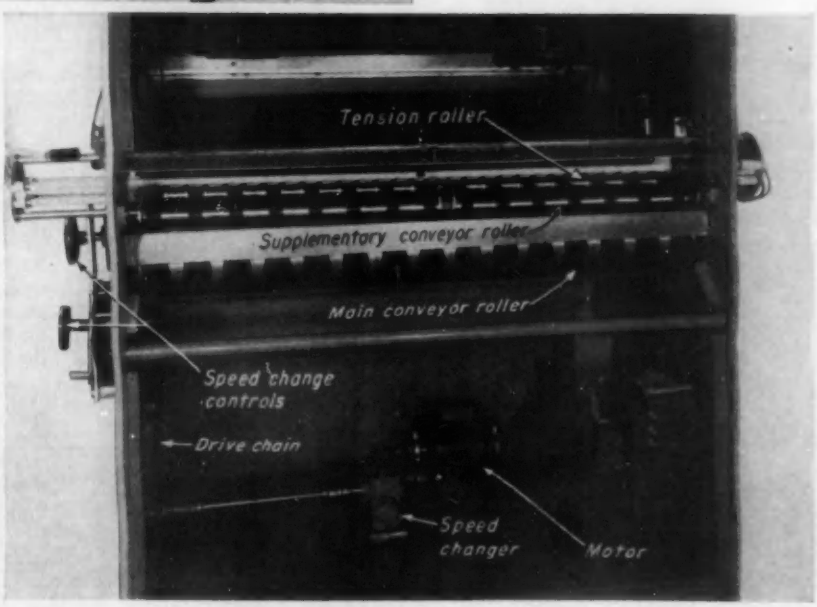
Sharper Definition Reducing Camera in Simpler Package

Redesign of the Neoflow reducing camera, Peerless Photo Products, Shoreham, N. Y., has simplified the precision of manufacture and improved the camera's performance characteristics. A new conveyor system provides firmer control over photocopied material by means of a multiple belt arrangement and additional rollers. Adjustment of the optical system is more precise and easily effected—a lead-screw shaft aligns mirrors and lens; the light passed through the aperture is more sensitively regulated; the number of optical elements reduced. For speed changing, an electric gear-selector system has been replaced by a mechanical control.



ECONOMY OF MANUFACTURE is accomplished in part through simplification of the mirror assembly. In previous model, two upper mirror nests were required to house a 5-mirror assembly. Redesign of the optical system needs only one upper nest to hold two mirrors. The nest support-arm slides along the mast on ball-bearing rollers. The roller collars can be adjusted to eliminate play between rollers and mast. The reducing lens bracket is mounted in the keyway of the lower support-arm. The bracket is removable with lens in bracket, for quick change-over. The two lower mirrors (not shown) are hinged together on a cross girder in trunnion support. The second mirror is swiveled into the light path for reverse-reading copies only. A threaded lead-screw shaft has been installed to accurately position the upper mirror nest and lens arm, and to furnish positive alignment of horizontal elements. The mirror nest is adjusted by rotating the shaft via the lower hand-wheel. Alignment of the lens arm is made by rotating the threaded support-arm sleeve on the shaft. Relative positions of the mirrors and lens are indicated by five-digit counters. Accuracy of focus is within a limit of 0.0025 inches. Construction of the camera is so standardized that three separate models can be built on the same basic design. Single reduction right-and-reverse reading model, as shown, can be modified in the field to either a two-reduction or six-reduction model. Change-over is accomplished through addition of parts and re-focusing.

(continued on next page)

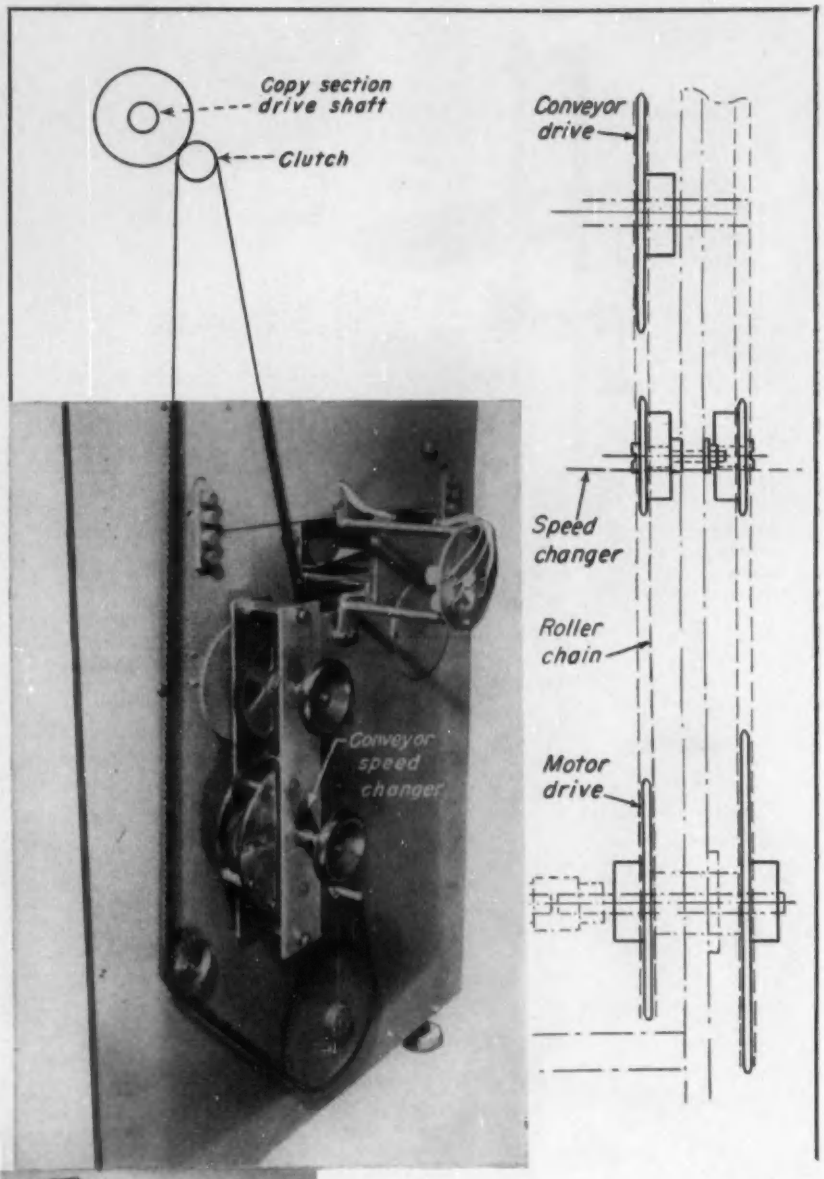


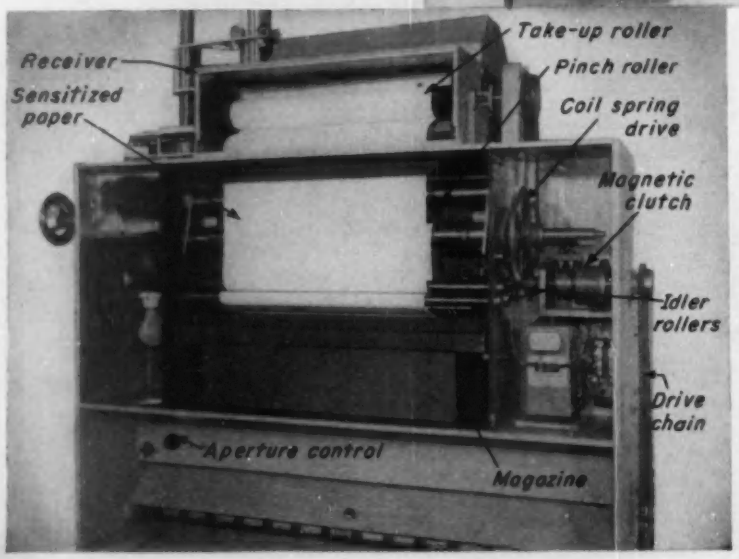
IN PLACE OF A FULL-WIDTH BELT, the main conveyor employs an array of fifteen 2-in. wide endless flat-web belts. The belts travel on two 5-in. dia rollers, and are tensioned and aligned by a 2-in. idler shaft with adjustable collars. Two new supplementary conveyors keep the copied material flat and aligned in passing through the exposure area. Fifteen 1-in. flat-web belts ride on the two 2-in. dia. rollers and tensioning roller of each supplementary conveyor. The belts are friction-driven by the main conveyor. The inner roller of the supplementary conveyor has reduced diameter where belt is not carried, for clearance for fingers that guide original. By adjusting the seating of the supplementary conveyors in the side brackets, grab is controlled to accommodate the thickness of the copied material.

Reducing Camera (continued)

A MECHANICAL ARRANGEMENT is used in place of an electrically actuated gear system. The all-mechanical drive requires less maintenance. Power is supplied by a ¼-hp. motor with a 100:1 speed reducer. The main conveyor is driven by roller chain through a gear assembly which offers two-speed selection and reversal of travel. Speed and travel is adjusted by means of two handwheels, as determined by the size of reduction desired. The single-driven roller of the copy section is driven by a separate chain and second 3-speed selector through a magnetic clutch and pinion-and-gear combination. The clutch is engaged as material to be copied passes through the exposure area, to cause feet of sensitized material. Speed synchronization between canveyor and copy-section roller is accurate to 0.1 per cent. Close synchronization together with increased sensitivity and precision of optical adjustments accounts for the more sharply defined photocopies.

In former design, the width of the slot in front of the photosensitive material was adjustable; the slot above the material to be copied was fixed. The arrangement is now reversed. More precise and wider range of light control results; width of light beam which passes through the aperture above original material is much greater than that which passes through slot in front of photosensitive material. To reduce reflections which might degrade the image, surface edges of the slot have been rounded. Dials on the front and rear panels are used to vary the width of aperture; two rods carried by arms are adjusted through self-locking worm gear connections.



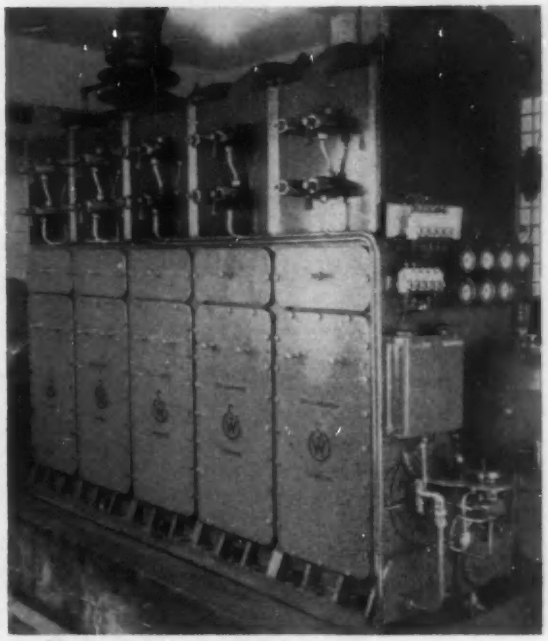


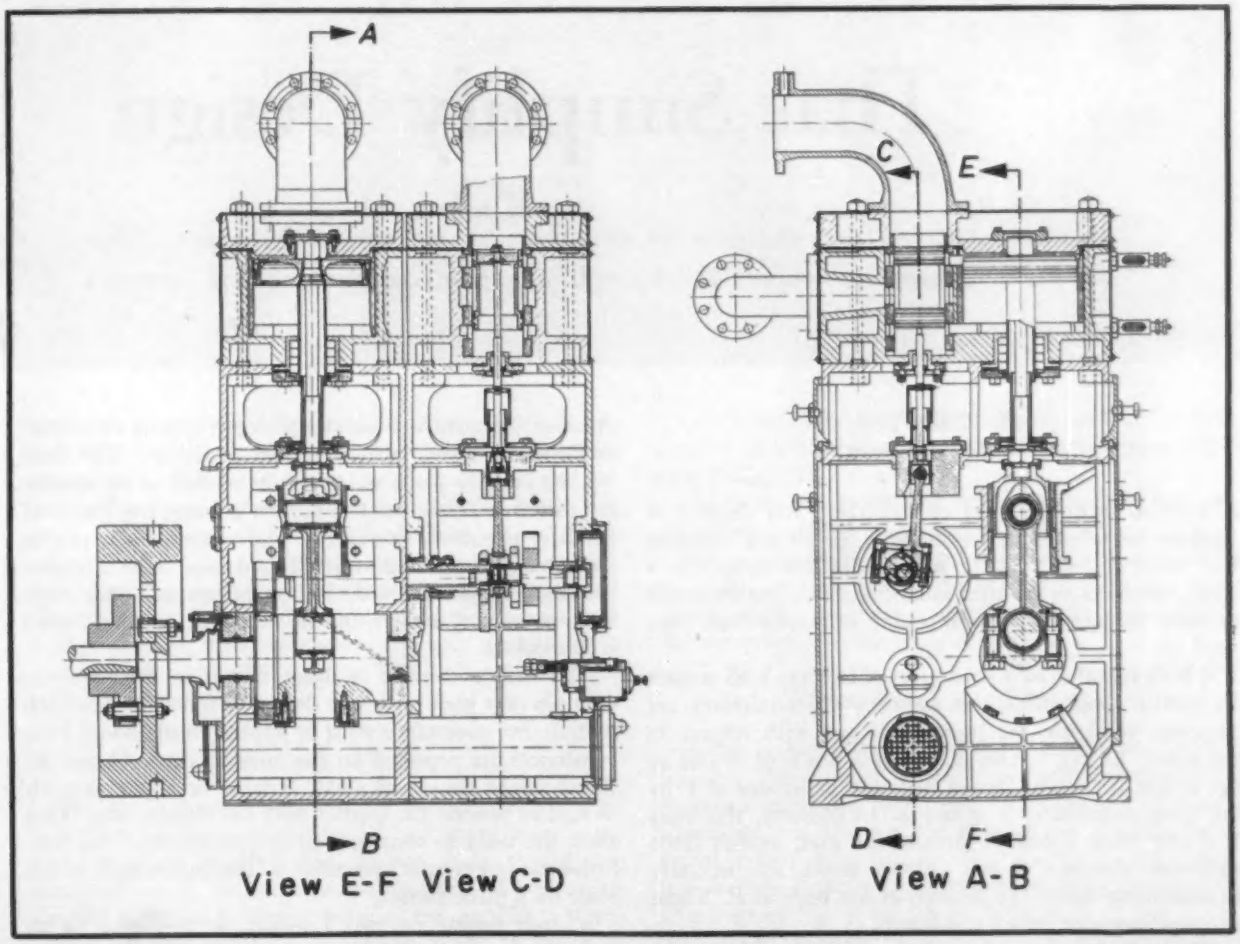
THE COPY SECTION has included an additional idler roller, to increase the tension on the photosensitive material. The material passes the image point absolutely flat and in focus. New arrangement uses a pair of velvet-covered fixed-position rollers to pressure the material against a platen. The platen is adjustable to thickness of the sensitized material. In the receiver, material is wound on roller that is driven by a non-synchronized spring take-up drive. Take-up roller and drive roller are aligned by suspending the receiver in a saddle; thus, sensitized material winds evenly. Material passes into receiver through two pivoted jaws in top of camera; on removal of receiver the jaws close to form a light-trap. All plate joints enclosing the copy section ar mortised, to obviate use of sealants.

Adaptable Steam Engine

A steam engine capable of incorporating up to six cylinder units has been developed by Spillingwerk, Hamburg, Germany. Available steam may be effectively utilized; increased power requirements can be readily accommodated. The engine has a vertical cylinder-block similar to a diesel. Units may be joined in any number one to six. Addition of a unit requires only a change in crankshaft and flywheel; no other parts need be replaced. The camshaft is extended by addition of a section.

The self-contained steam engine is shown (right) with 5-unit split-assembly. One-to-six unit availability gives overall range of 10 to 1000 hp. Pressure range is from 85 to 510 psi. Initial unit is designed for max speed of 1500 rpm.





ALL UNITS use same crankshaft and motivate common flywheel. Other parts fit unit-to-unit. The camshaft and crankshaft contrarotate at identical speed, the camshaft controlling in and outlet timing of piston-type slide-valves. Counter-balance obtained contributes to smooth engine operation, making installation possible on light foundations. Wear is reduced by short-stroke design; piston speed ranges from 11.5 to 13.8 fps. Efficiency, it is claimed, compares favorably with conventional low-speed steam engines, with economy superior to steam turbine up through 1000 hp.

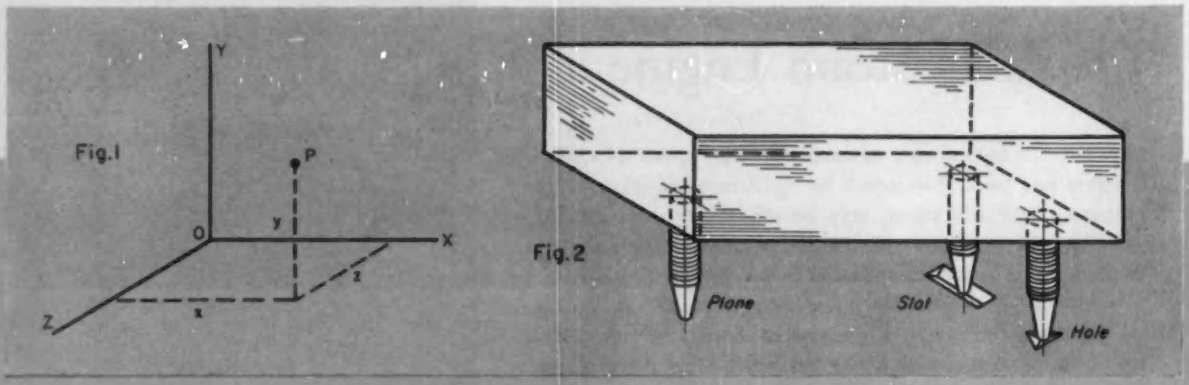


Fig. 1—In rectangular coordinate system, the six degrees of freedom are represented by translation along each of the three axes, plus a rotation about each axis.

Fig. 2—Simple and accurate method of maintaining the relative locations of two bodies by means of three pins with spherical ends mating with a vee-slot, a trihedral hole and a plane bearing surface. This is generally accepted as a fully constrained system.

Kinematic Concepts That Simplify Design

Some basic concepts that apply to the design of any linkage or mechanism. They may suggest methods of improving or simplifying even complex machine elements.

M. F. SPOTTS
Northwestern University

ALTHOUGH THE CONCEPTS of constraint and degrees of freedom are referred to continuously, experience indicates that most designers fail to apply them effectively. As a result, mechanisms are often more complex, more expensive or more susceptible to wear and inaccuracies than they need be.

A body is said to have six degrees of freedom with respect to another body when six numbers or coordinates are necessary to define the position of one with respect to the other. In Fig. 1, axes X, Y and Z are fixed in one of the bodies at O. The second body can be located at *P* by the three coordinates x, y and z. In addition, the body at *P* can rotate about all three of the axes, so that three additional numbers, in this instance angles, are necessary to completely define the position of the body at *P*. These six coordinates are called constraints.

When all six constraints are present and properly located between two bodies, there can be no relative motion between them. For example, one of the supports for the body of Fig. 2 rests in a shallow trihedral hole with three points of contact. It resists motion in three directions. Another leg rests in a vee-slot with two points of contact and thereby resists motion in two directions. The third leg bears upon a plane and can resist motion in the remaining direction. Thus, relative motion between the body and the base is entirely prevented. The two members can be separated and replaced as often as desired with assurance that their relative positions will be unchanged. Only nominal accuracy of manufacture is necessary, and machining is minimized.

The sliding carriage or table shown in Fig. 3 is an example of a body with one degree of freedom. For such motion, five constraints must be applied to the body. Four constraints are provided on the table at *A*, *B*, *C*, and *D*. These might consist of small buttons or knobs properly located to provide the contact with the circular way. They allow the body to slide as well as rotate around the way. Rotation, however, is prevented by the button at *E* which bears on a plane surface.

A shaft resting on two V-blocks, as in Fig. 4, is an example of a body with four constraints and two degrees of freedom. Each V-block resists motion in two directions. The two motions possible are longitudinal translation and rotation.

The nut on the unthreaded bolt of Fig. 5(A) illustrates

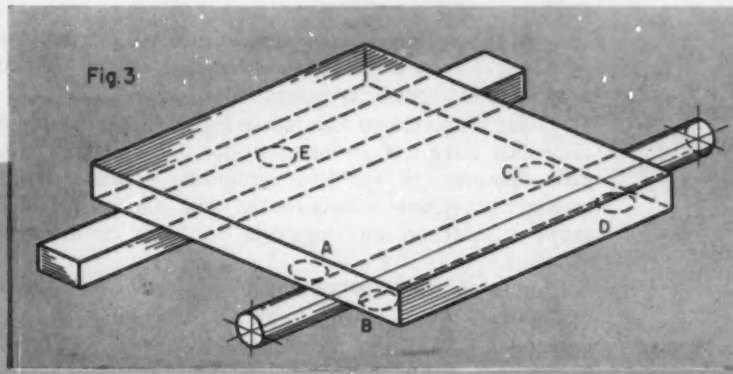


Fig. 3—Body with one degree of freedom. Button or knobs at *A*, *B*, *C* and *D* provide four constraints. Button at *E* prevents rotation about the way, leaving sliding along the way as the only motion possible.

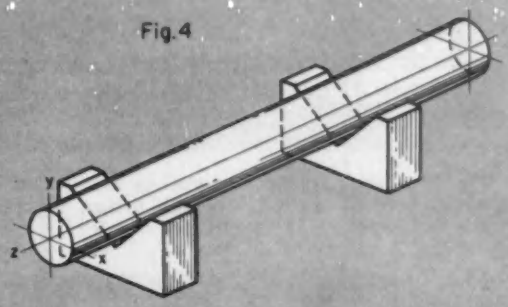


Fig. 4—Shaft on V-blocks represents a body with two degrees of freedom. Shaft can slide along as well as rotate about Z axis.

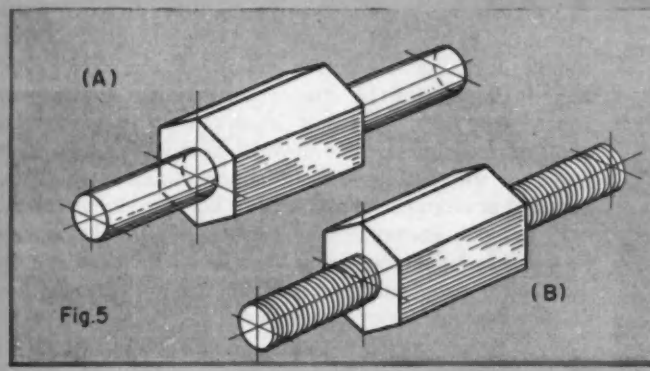


Fig. 5—Nut on unthreaded bolt (A) represents a two degree of freedom system. Rotation as well as translation along the bolt are possible. When bolt is threaded, (B), translation and rotation are interdependent, and only one degree of freedom remains.

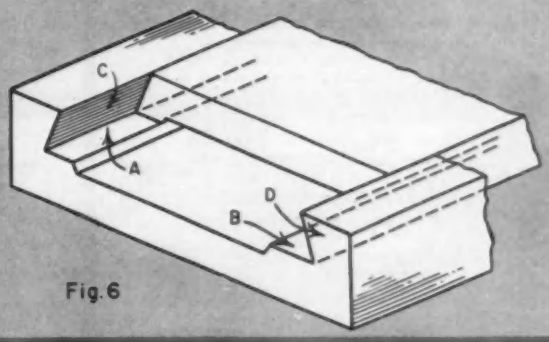


Fig. 6—Conventional dove-tail slide is an adaptation of Fig. 3 Machining requirements and complexity have been increased but the load capacity has been increased.

another body with two degrees of freedom. The nut can slide longitudinally as well as rotate. Other motions are prevented by the shape of the parts. In Fig. 5(B), the bolt and nut are threaded. The nut can still rotate and move longitudinally, but the two motions are no longer independent. A simple algebraic equation gives the longitudinal position in terms of rotation and vice versa. Technically, there is but one degree of freedom with four ordinary constraints. The fifth constraint relates the translation and rotation. Hence the motions of a body are not necessarily all independent.

Kinematic Design

The mechanisms of Figs. 2 and 3 were constructed with point contacts between the bodies. Although there is no such thing as a point, the contact areas nevertheless were very small. In addition, the number of constraints was just sufficient to give stability to the assembly. Mechanisms so constructed are said to be made by the principles of *kinematic* or *geometric design*, and generally have the following desirable features:

(1) Forces, including friction, at each point of contact are easily determined and are predictable;

(2) Satisfactory functioning of the assembly is independent of the tolerances on the component parts within wide limits; and

(3) Errors in functioning result mainly from wear and are consistent rather than erratic.

The principal disadvantage of kinematic design lies in the small bearing surfaces which must carry the loads. Therefore, this principle is of use primarily in instruments and equipment for light-duty service.

Semi-Kinematic Design

When loads are large as usually occurs in machine tool practice, the contact points previously considered are expanded into finite areas and the design is called *semi-kinematic*. For example, the slide of Fig. 3 might be designed to look something like Fig. 6. The bearing surfaces and the load-capacity are increased, and the principal disadvantage of Fig. 3 has been overcome.

However, another disadvantage has been introduced because it is now necessary to provide small and closely controlled clearances between the various parts. In addition, it is assumed that bearing will occur simultaneously over surfaces *A* and *B* as well as *C* and *D*. In general, any

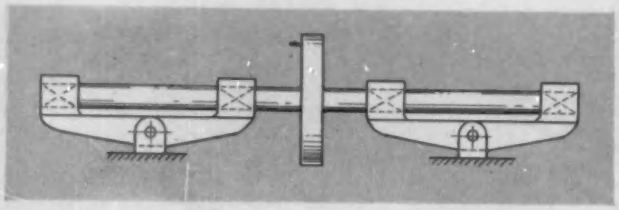


Fig. 7—A shaft can be supported at four points without becoming over-constrained. For this design, the bearing loads are determinate.

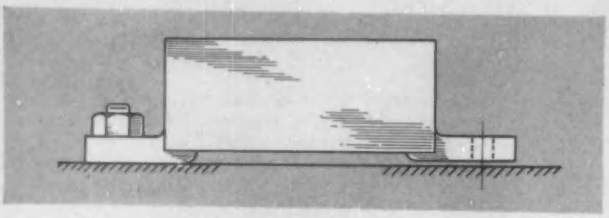


Fig. 8—Over-constraint caused by misalignment of bolt holes can induce large stresses at assembly.

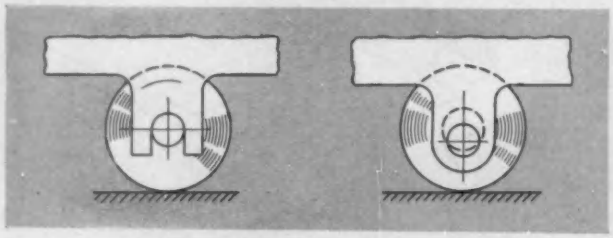


Fig. 9—Inversion of mechanisms can often be used to offset effects of wear or misalignment. In the left-hand sketch wear between axle and bearing does not affect fit between parts. With the design at right, however, wear impairs the fit between bearing and journal.

departure from kinematic design requires a higher quality of workmanship to secure proper functining of the mechanims.

The exact location of the forces in Fig. 6 cannot be predicted since small variations in dimensions can cause a large shift in the location and magnitude of the contact forces. If the V-blocks of Fig. 4 are replaced by conventional journal bearings, the design becomes semi-kinematic.

Indeterminate Structures

As previously mentioned, the forces holding a body in position are called the constraints of the system and are applied at the points of contact with other bodies. When the number and location of the constraints or reactions are just enough to provide stability to the system, it is said to be statically determinate. Reactions can be found by simple statics by taking summations of the forces and moments.

If more than the minimum number of constraints required for stability are present, the system is said to be over-constrained or statically indeterminate. Thus a continuous shaft supported by three bearings is over-constrained. In general, over-constraint causes stresses and forces to be induced in the system. In the shaft, for example, the three bearings would rarely be aligned exactly, and if the shaft is forced in place, stresses are induced in addition to the reaction forces on the bearings.

Another common cause of over-constraint is temperature gradients. Often these induce additional stresses in the parts of an indeterminate system.

A body supported on four feet or legs is another example since only three feet are necessary for stability. It is possible, however, to use four supporting points without making the system indeterminate. For example, Fig. 7 shows a shaft on four supports but with determinate reactions.

Because of the finite areas involved, localized errors in manufacture also can cause indeterminacy. Thus, because of inaccurate machining, bolting-up stresses may be induced in the body of Fig. 8 even though the system may otherwise be determinate.

Incomplete Elements

An element is said to be incomplete if, when it is assembled to the other parts of the mechanism, an unwanted degree of freedom is present. If the V-blocks of Fig. 4 are replaced by conventional journal bearings in which some clearance must be present, the shaft then becomes incomplete. The dovetail slide of Fig. 6 is composed of incomplete elements since clearance must be provided or sliding cannot take place between the members.

In general, incomplete elements result in changing a design from kinematic to semi-kinematic. Errors caused by incomplete elements are erratic; they are not constant nor do they fluctuate about a mean value.

Inversion

Wear and accuracy in a mechanism are influenced by the method of assembly. Proper consideration of the effect of one member on another will sometimes show which of several possible arrangements is best.

As a simple example, consider the bearings and axle of a freight car shown schematically in Fig. 9 (left). Wear between axle and bearing causes no harmful effect insofar as the fit between the parts is concerned. The axle remains round even after considerable wear. The bearing also remains round and maintains a good fit on the shaft.

An inversion of the above mechanism in which the shaft is attached to the frame with the wheel running freely on the axle is shown in Fig. 9 (right). Any wear causes the hole in the wheel to become larger with a loss of fit between the parts. In addition, the shaft does not remain circular since all the wear is on one side.

Other examples of inversion are:

1. A slider can be constructed to operate inside a tube which serves as the guide, like a piston in a cylinder. In the inversion, the slider might consist of a block with a hole in it to operate on a rod as the guide.

2. A cylinder head can be held in place by cap screws threaded into the block. In the inversion, fixed studs are placed in the block and the head retained by the nuts which are threaded to the studs.

EDITOR'S NOTE—Another basic aspect of mechanism design is the effect of friction. In *Product Engineering*, May 1952, pages 124-219, Mr. J. M. Eastman outlines the requirements for good design from a friction viewpoint. He also illustrates the application of these principles to commonly used mechanisms.

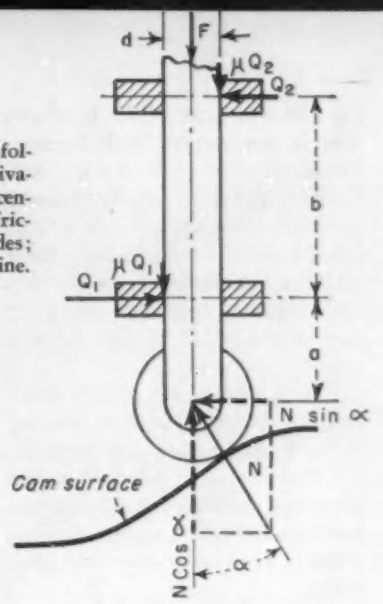


Fig. 1—Force diagram for radial roller-follower cam system. Assumptions used in derivation are: (1) reactions Q_1 and Q_2 are concentrated at the centers of the guides; (2) friction coefficient is same at both guides; and (3) force F acts along stem centerline.

PLATE CAM DESIGN

pressure angle analysis

Blending of cam profile curves was discussed in the first part of this series, *Product Engineering*, February 1955, pages 156–162. The next step in the design is to determine the maximum pressure angle to keep compression stresses within allowable limits. This can be done quickly and easily with a comprehensive set of charts developed with the aid of automatic computing equipment.

MARTIN KLOOMOK and ROBERT V. MUFFLEY
Manager, Scientific Computation Lab. Associate Engineer
International Business Machines Corp.

SYMBOLS

a = Overhang of radial follower stem beyond guide, in.
A = Point of contact of roller with cam
b = Distance between radial follower stem guides, in.
B = Position of follower arm pivot
c = Distance from cam center to follower arm pivot, in.
C, C' = Position of follower center
d = Diameter of radial follower stem, in.
F = External load on radial follower stem, lb
l = Length of follower arm, in.
L = Lift, in.
N = Normal force on roller, lb
O = Cam shaft center
Q_1, Q_2 = Horizontal reactions at radial follower stem guides, lb
R = Radius measured from camshaft center to follower roller center, in.
R_o = Minimum radius for event, in.
T = Torque on swinging follower arm, in.-lb
α = Pressure angle at any point, deg
α_{max} = Max pressure angle for event, deg
β = Total angular rotation of cam for a complete event, deg
δ = Angle between l and c, deg
ϵ = Angle between l and R, deg
θ = Angular rotation of cam measured from a space fixed reference, deg
λ = Angle between the normal to the cam surface and the line OC', deg
μ = Coefficient of friction between guides and radial follower stem
τ = Total angular rotation of follower arm for a complete event, deg
ϕ = Angular rotation of cam measured from a line joining cam and follower roller centers, deg
ψ = Angle between c and R, deg

THE ANALYSIS OF A CAM SYSTEM to meet pressure angle requirements involves two factors: (1) the value of the maximum pressure angle for a given choice of cam parameters; and (2) the value of the pressure angle which is tolerable from a consideration of the forces in the system.

In a radial follower system such as Fig. 1, the ratio of the normal force N on the cam surface to the follower-stem output force F is called the magnification factor. This ratio is unity for a zero pressure angle and increases as pressure angle α increases. The relationship between N/F and α depends upon the dimensions a, b and d of the follower stem and the coefficient of friction.

Taking the summation of forces and moments in Fig. 1 for follower-stem equilibrium:

$$\Sigma F_x = 0 = Q_1 - Q_2 - N \sin \alpha \quad (1)$$

$$\Sigma F_y = 0 = N \cos \alpha - \mu Q_1 - \mu Q_2 - F \quad (2)$$

$$\Sigma M_{Q1} = 0 = -bQ_2 + \mu\, dQ_2 + \frac{d}{2}F - \frac{d}{2}N \cos \alpha + aN \sin \alpha \quad (3)$$

Solving for the magnification factor,

$$\frac{N}{F} = \frac{b}{b \cos \alpha - (2\mu a + \mu b - \mu^2 d) \sin \alpha} \quad (4)$$

For a representative set of dimensions, Fig. 2 indicates

the effect of μ on N/F. It is seen that in any system, N/F becomes infinite at some value of α less than 90 deg. Before it reaches infinity, however, moment $aN \sin \alpha$ may cause bending of the follower stem, and the surface loads on the cam will promote rapid cam disintegration in the region of high pressure angle.

This has led to the pactice of setting an arbitrary limit of 30 deg. on α. Higher values may be practical under certain conditions, but the forces developed should be evaluated and checked against the load capacity of the cam roller and other parts.

Common practice is to prepare a complete cam layout, then find the maximum pressure angle with a protractor. However since changes needed at this time can be costly, data are developed herein from which this pressure angle can be calculated quickly before proceeding with the layout.

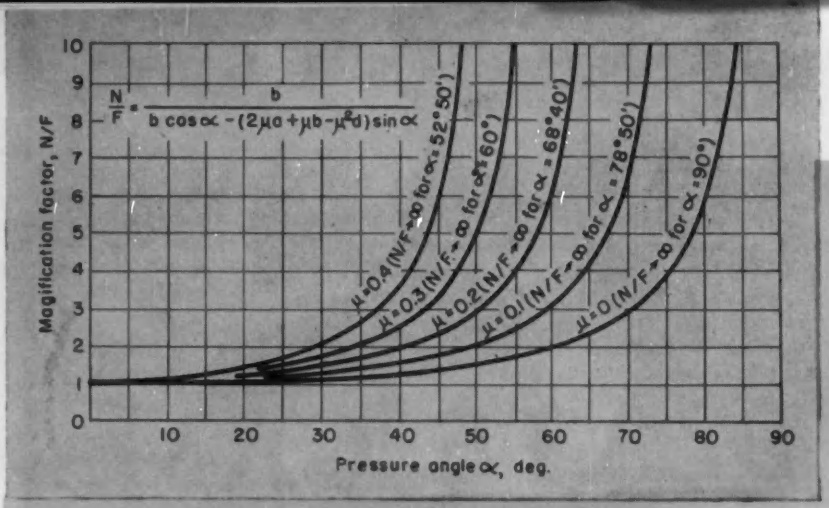

Magnification factor, N/F
Pressure angle ∝, deg.
N/F = b / (b cos∝ − (2μa + μb − μ²d) sin∝)
μ=0.4 (N/F→∞ for ∝=52°50')
μ=0.3 (N/F→∞ for ∝=60°)
μ=0.2 (N/F→∞ for ∝=68°40')
μ=0.1 (N/F→∞ for ∝=78°50')
μ=0 (N/F→∞ for ∝=90°)

Fig. 2—Pressure angle plotted against the force magnification factor N/F for the following representative dimensions: $a = 1.0$ in.; $b = 2.0$ in.; $d = 0.5$ in. At each value of μ, the magnification factor becomes infinite at some value of α less than 90 degrees.

Radial Follower System

Referring to Fig. 3, pressure angle α is defined as the angle included between the line of action of the roller follower center C and the normal CA to the surface at the point of contact A. The cam is assumed at rest, with the follower center rotating about it clockwise from position C to C', swinging through the small angle $d\theta$. From the figure,

$$\alpha' = \tan^{-1} \frac{C'E}{CE} \qquad (5)$$

As $d\theta$ is decreased, angles OCE and ACC' approach zero. Simultaneously, CD approaches CF, and both approach coincidence with CE. In the limit,

$$\alpha' = \tan^{-1} \frac{1}{R} \frac{dR}{d\theta} \qquad (6)$$

By geometry, since the sides of α and α' are mutually perpendicular in the limit, α becomes equal to α'. Thus

$$\alpha = \tan^{-1} \frac{1}{R} \frac{dR}{d\theta} \qquad (7)$$

If the appropriate relationship is substituted for $dR/d\theta$, Eq (7) can be evaluated for any motion curve. For example, for cycloidal motion

$$R = R_o + L\left(\frac{\theta}{\beta} - \frac{1}{2\pi} \sin 2\pi \frac{\theta}{\beta}\right) \qquad (8)$$

$$dR/d\theta = \frac{L}{\beta}\left(1 - \cos 2\pi \frac{\theta}{\beta}\right) \qquad (9)$$

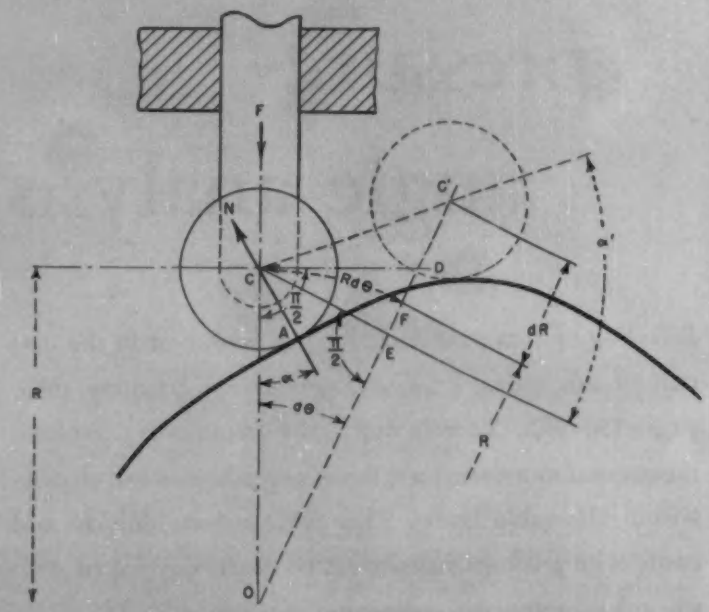


Fig. 3—Pressure angle geometry for a radial cam follower.

$$\alpha = \tan^{-1} \left[\frac{\frac{L}{\beta}\left(1 - \cos 2\pi \frac{\theta}{\beta}\right)}{R_o + L\left(\frac{\theta}{\beta} - \frac{1}{2\pi} \sin 2\pi \frac{\theta}{\beta}\right)} \right] \qquad (10)$$

Several steps are usually required to obtain the maximum value of α in a specific problem. First the maximum must be located by differentiating α with respect to θ and setting the resultant transcendental expression equal to zero. The value of θ so obtained is substituted into Eq (10). If α_{max} is too large, the parameters must be adjusted and the entire process repeated.

This procedure is too time-consuming for everyday use. The designer needs a precalculated maximum pressure angle corresponding to the values of L, R_o and β in the problem such as is obtainable from nonogram in Fig. 4.

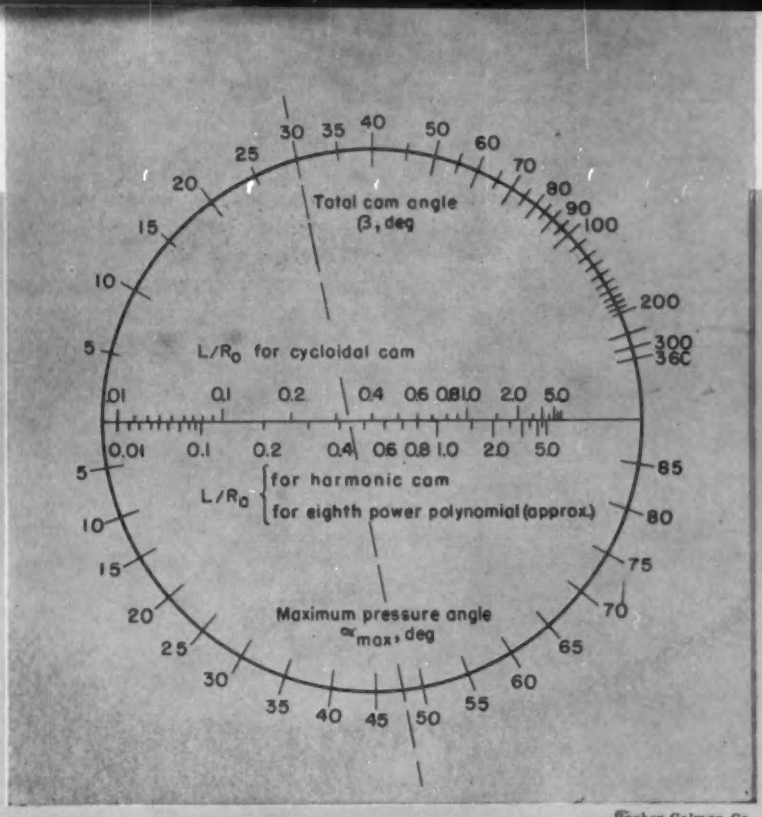


Fig. 4—Nomogram for finding maximum values of pressure angle for different combinations of system parameters

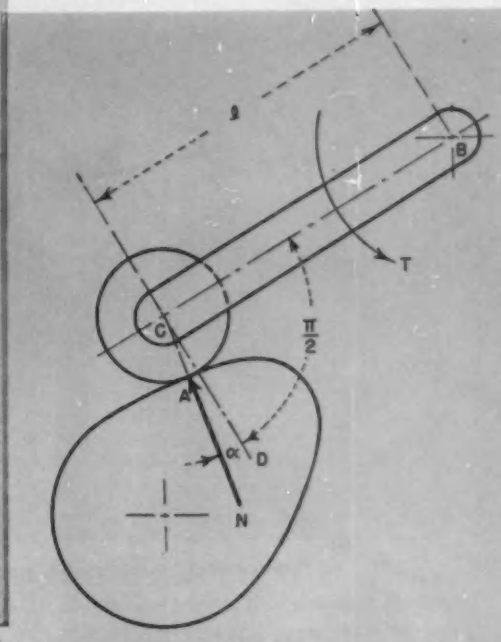


Fig. 7—Torque and normal load diagram for a swinging cam-follower.

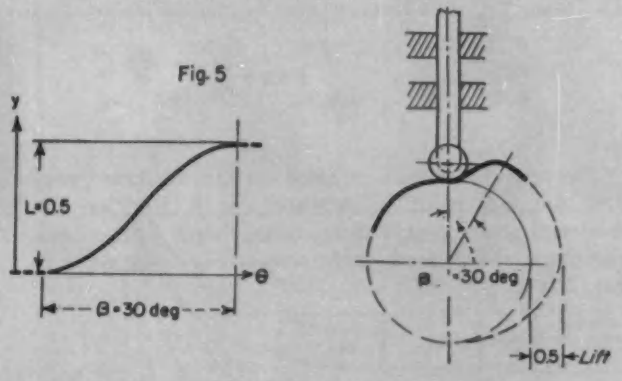


Fig. 5—Radial follower system for Example 1. A lift of 0.5 in. is required with a cam rotation of 30 degrees.

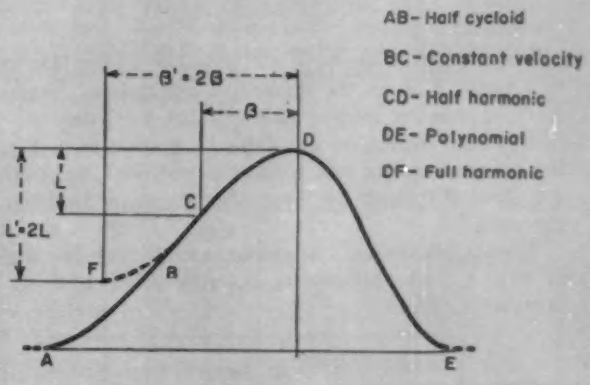


Fig. 6—Combination cam profile in a radial follower system. To solve use L' and β' and proceed as with a single curve.

This chart was developed by evaluating the maximum pressure angle equations for given values of the dimensionless parameter L/R_o, varying β from O to 360 deg.

EXAMPLE 1. Dwell, Rise, Dwell (Fig. 5)

Required: A cycloidal curve with $L = 0.5$ in. and $\beta = 30$ deg.

First Solution: Assume $R_o = 1.5$ in.; then $L/R_o = 0.33$. from Fig. 4, $\alpha_{max} = 48$ deg, which is too large.

Second Solution: If R_o is increased to 2.9 in., L/R_o becomes 0.17 and α_{max} becomes 30 deg. Alternately, if space is at a premium, β can be increased and the cam run faster to maintain the lift time at a constant value.

EXAMPLE 2. Dwell, Rise (accelerate), Rise (constant velocity), Rise (decelerate), Return, Dwell (Fig. 6)

Half-cycloids and half-harmonics are sometimes used with constant velocity sections. With a half-curve β and L must be modified before using the chart.

In Fig. 6, a half-harmonic is required between C and D. Since the pressure angle chart is based on full harmonic profiles, the parameters of curve DC must be doubled, in effect extending the curve to point F:

Thus, $\beta' = 2\beta$,

$L' = 2L$,

and $R_o' = R_F = R_D - 2L$

Using β', L' and R_o', the analysis can be completed as in Example 1. If desired, a pressure angle check can be made on curve AB with the same general procedure.

Swinging Follower System

In Fig. 7, the pressure angle α can be defined as the angle between CA, the normal to the curve at the point

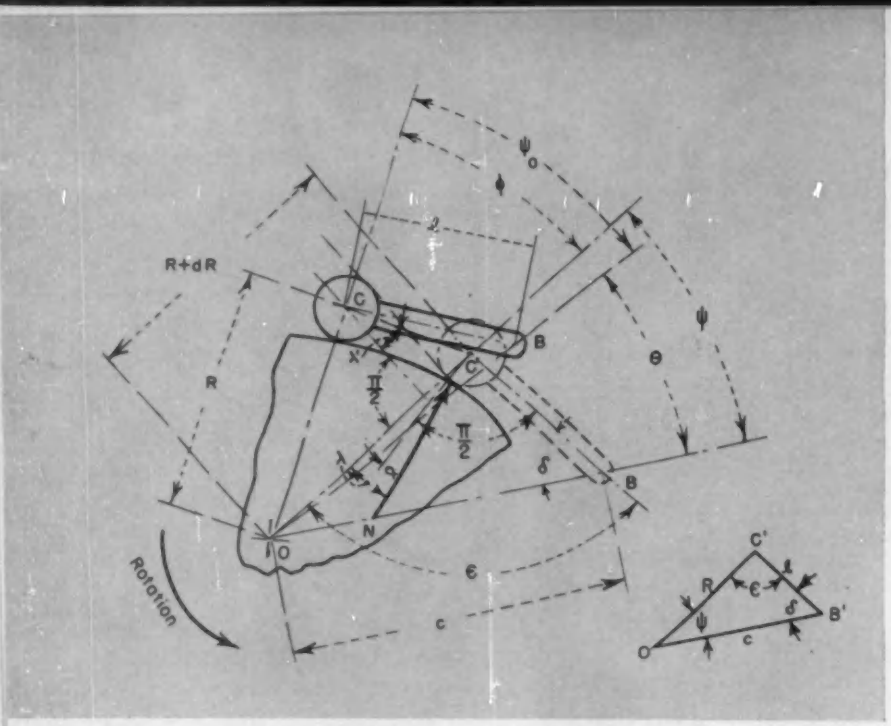


Fig. 8—Pressure angle geometry for a swinging-cam-follower problem.

of roller contact, and DC, the normal to the centerline of the follower arm. Neglecting friction, and taking moments about pivot B,

$$\frac{Nl}{T} = \frac{1}{\cos \alpha} \tag{11}$$

The Torque ration Nl/T is comparable to the magnification factor N/F in the radial follower system. Similarly, Nl/T approaches infinity as α approaches 90 deg.

A general expression for α can be derived from Fig. 8. For convenience the cam is taken at rest, with the follower arm pivot B rotating clockwise through angle θ relative to the cam.

The angle λ in Fig. 8 is analogous to the pressure angle α in Fig. 3, and similarly, as $d\phi$ approaches zero, λ' approaches λ. Thus

$$\lambda = \tan^{-1} \frac{1}{R} \frac{dR}{d\phi} \tag{12}$$

Also,

$$\alpha = \frac{\pi}{2} - (\epsilon - \lambda) \tag{13}$$

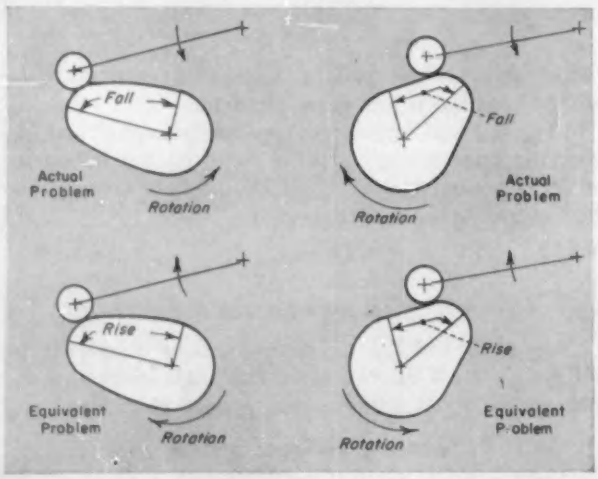


Fig. 9—Conversion of "fall" portion of cam to an equivalent "rise" to permit use of the charts.

The small triangle $OB'C'$ can be solved for R, ϵ and ψ.

$$R = \sqrt{l^2 + c^2 - 2lc \cos \delta} \tag{14}$$

$$\epsilon = \sin^{-1} \left[\frac{c}{R} \sin \delta \right] \tag{15}$$

$$\psi = \cos^{-1} \frac{c^2 + R^2 - l^2}{2Rc} \tag{16}$$

Also, from Fig. 8,

$$\phi = \psi_o - (\psi - \theta) \tag{17}$$

Differentiating Eq (17)

$$\frac{d\phi}{dR} = \frac{d\theta}{dR} - \frac{d\psi}{dR} \tag{18}$$

Differentiating Eq (14) and taking reciprocals

$$\frac{d\theta}{dR} = \frac{R}{lc \sin \delta \dfrac{d\delta}{d\theta}} \tag{19}$$

Differentiating Eq (16)

$$\frac{d\psi}{dR} = \frac{c^2 - R^2 - l^2}{2R^2 c \sin \psi} \tag{20}$$

Collecting terms from Eqs (12), (15), (18), (19) and (20) and substituting in Eq (13)

$$\alpha = \frac{\pi}{2} - \sin^{-1} \left[\frac{c}{R} \sin \delta \right] + \tan^{-1} \left\{ \frac{1}{\dfrac{R^2}{lc \sin \delta \dfrac{d\delta}{d\theta}} - \dfrac{c^2 - R^2 - l^2}{2Rc \sin \psi}} \right\} \tag{21}$$

The above derivation is based on cam rotation "away from the pivot point" as shown in Fig. 8. Rotation "toward the pivot point," affects certain signs in the equations, and the pressure angle relationship comparable to Eq (21) is

$$\alpha = -\frac{\pi}{2} + \sin^{-1} \left[\frac{c}{R} \sin \delta \right] + \tan^{-1} \frac{1}{\dfrac{R^2}{lc \sin \delta \dfrac{d\delta}{d\theta}} + \dfrac{c^2 - R^2 - l^2}{2Rc \sin \psi}} \tag{22}$$

To evaluate Eq (21) or (22) for a given motion of the follower arm, the appropriate expressions are substituted for δ and $d\delta/d\theta$. To illustrate, if the motion of the follower arm is cycloidal,

$$\delta = \delta_o + \tau \left[\frac{\theta}{\beta} - \frac{1}{2\pi} \sin \frac{2\pi\theta}{\beta} \right] \tag{23}$$

Differentiating the resultant expression to compute a maximum yields an unwieldy transcendental equation. Therefore, the approach used herein was to evaluate the equations for given values of l c, τ and β and for values of θ/β from zero to one using an electronic calculator. These values were plotted and the maximum values picked out. Figs. 11-31 are the results of such calculations.

In these charts, the maximum value of pressure angle determined for each cam curve appears as a single point. These maximum values are grouped according to l/R_o ratios and plotted as a function of β/τ. All linear dimen-

sions have been converted to dimensionless form by dividing by R_o, and the effect of rotation "from" or "toward" the pivot is taken into account by plotting two complete sets of curves on each chart.

It is emphasized that these curves give only the maximum value of pressure angle. The location, if required, can be determined from the final cam layout.

Also, it has been assumed that the motion involves a "rise." For a "fall" motion, the maximum pressure angle can be determined by the same techniques used for the "rise," provided that the direction of cam rotation is reversed as illustrated in Fig. 9 before using the charts.

DESIGN CHARTS

To illustrate the use of the design charts, assume the following conditions for the cam in Fig. 10: rise between two dwells; cycloidal motion; $R_o = 1.50$ in.; $l = 2.25$ in.; $c = 2.50$ in.; $\tau = 10$ deg; $\beta = 60$ deg; and rotation away from pivot.

Solution:

$$l/R_o = 2.25/1.5 = 1.5$$
$$c/R_o = 2.50/1.5 = 1.67$$
$$\beta/\tau = 60/10 = 6$$

It is necessary to interpolate for both c/R_o and τ; however, this interpolation is not critical since an approximate value of the pressure angle is usually satisfactory. Chart values from Fig. 15 are:

c/R_o	1.50	1.75	1.50	1.75
τ, deg	2	2	30	30
α_{max}, deg	41.5	29.5	43.0	33.5

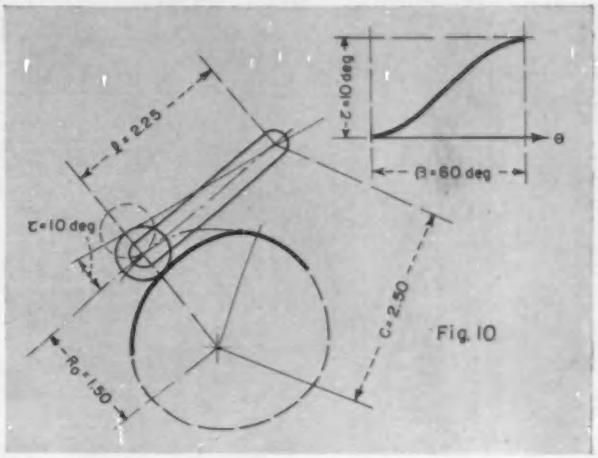


Fig. 10

Thus, for $c/R_o = 1.67$ and $\tau = 10$,

$$\alpha_{max} = 41.5 - \left[\left(\frac{1.67 - 1.50}{1.75 - 1.50}\right)(41.5 - 29.5)\right] = 33.3 \text{ deg}$$

This is somewhat larger than the 30 deg nominal safe maximum, but it should be safe in this instance. Friction is low in a swinging follower system and rotation away from the pivot eliminates any tendency for the roller to jam.

EDITOR'S NOTE—In the next article of this series, the importance of checking the minimum radius of curvature is shown and charts are provided for facilitating such studies. Calculation of minimum radius is essential (1) to determine "undercut," and (2), to evaluate surface stresses.

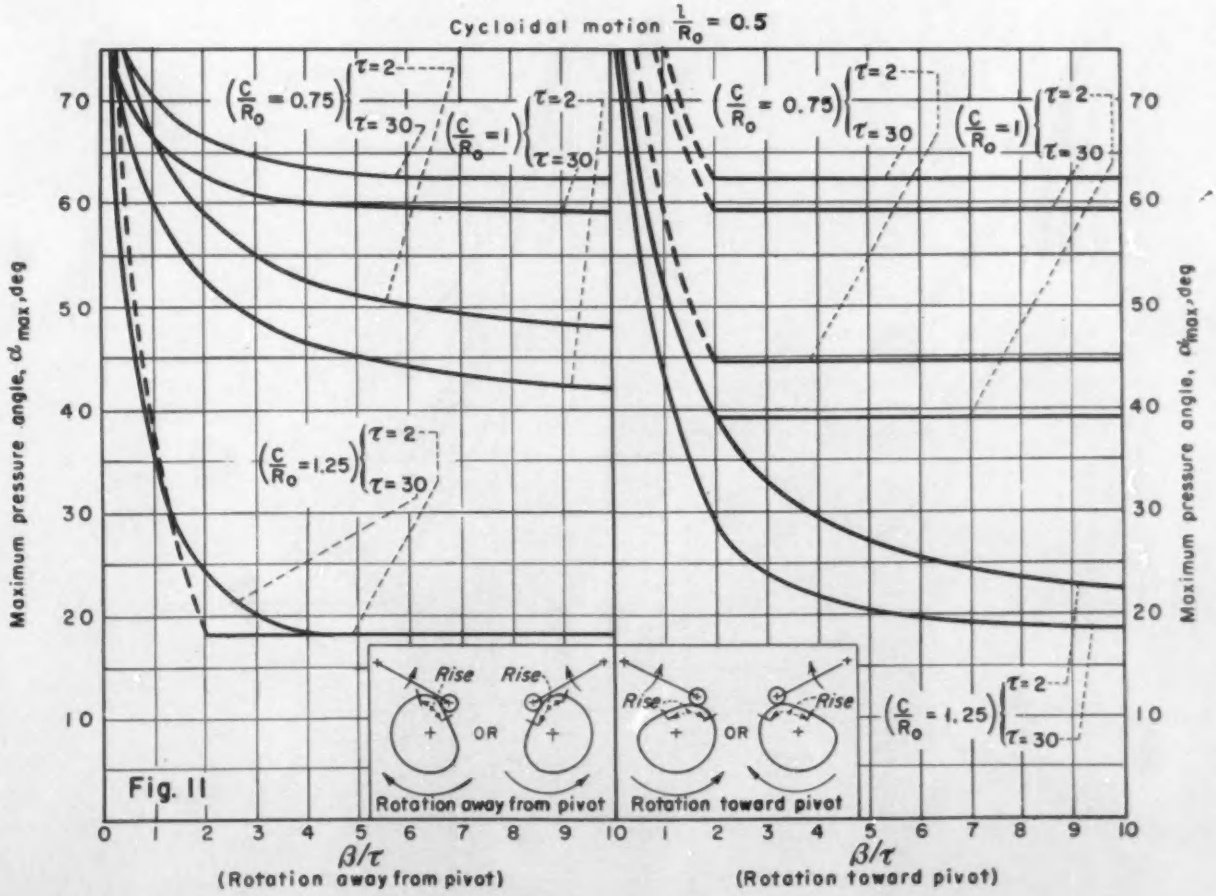


Fig. 11

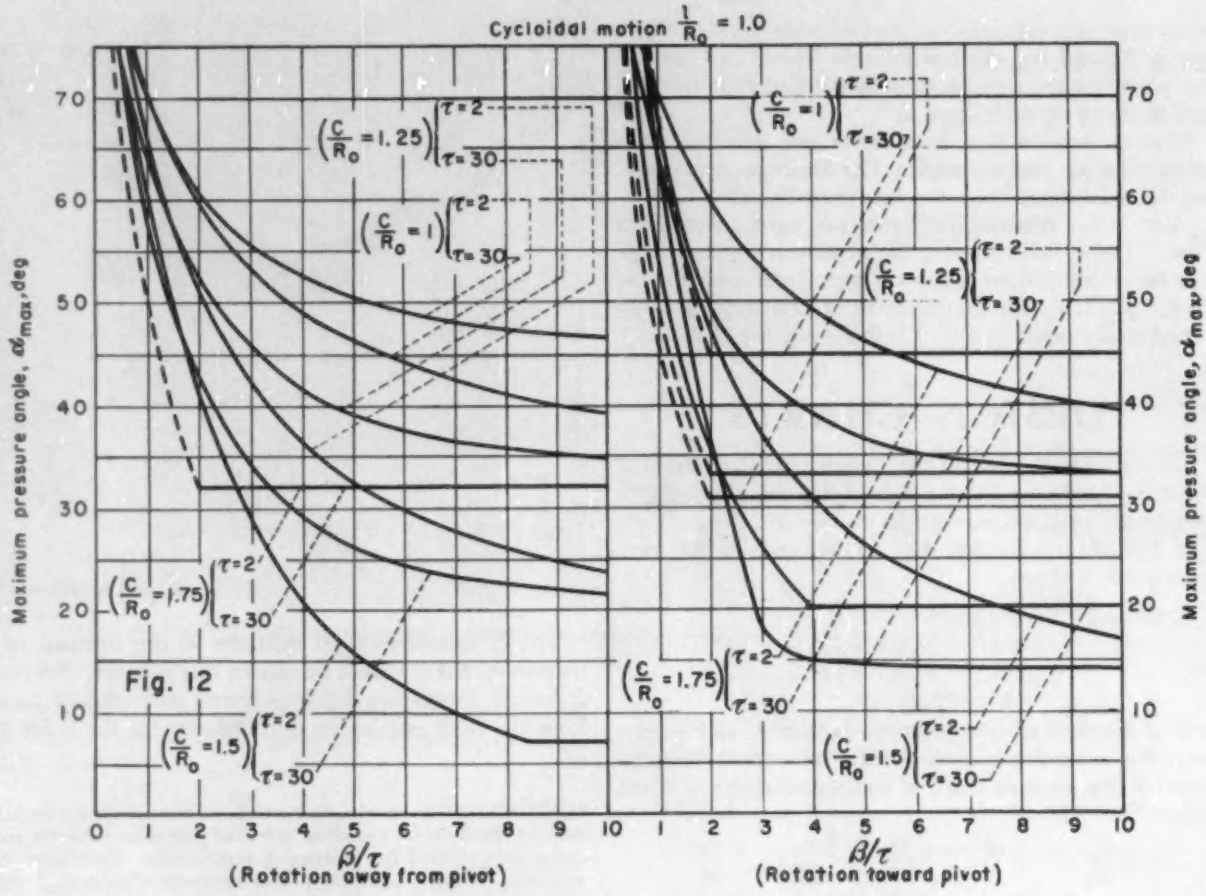

Cycloidal motion $\frac{1}{R_0} = 1.0$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 1.25\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 1\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 1.75\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 1.5\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
β/τ
(Rotation away from pivot)
(Rotation toward pivot)

Fig. 12

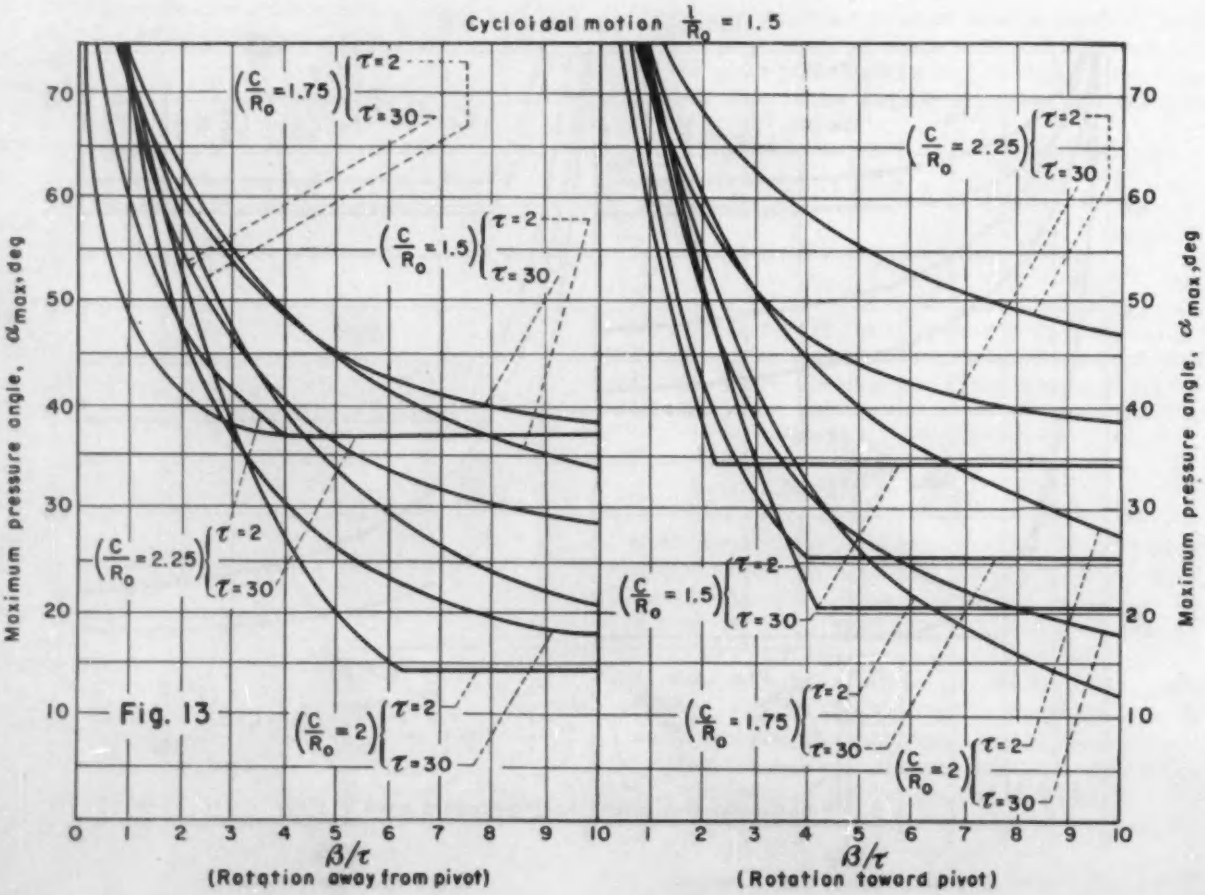

Cycloidal motion $\frac{1}{R_0} = 1.5$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 1.75\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 1.5\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2.25\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
β/τ
(Rotation away from pivot)
(Rotation toward pivot)

Fig. 13

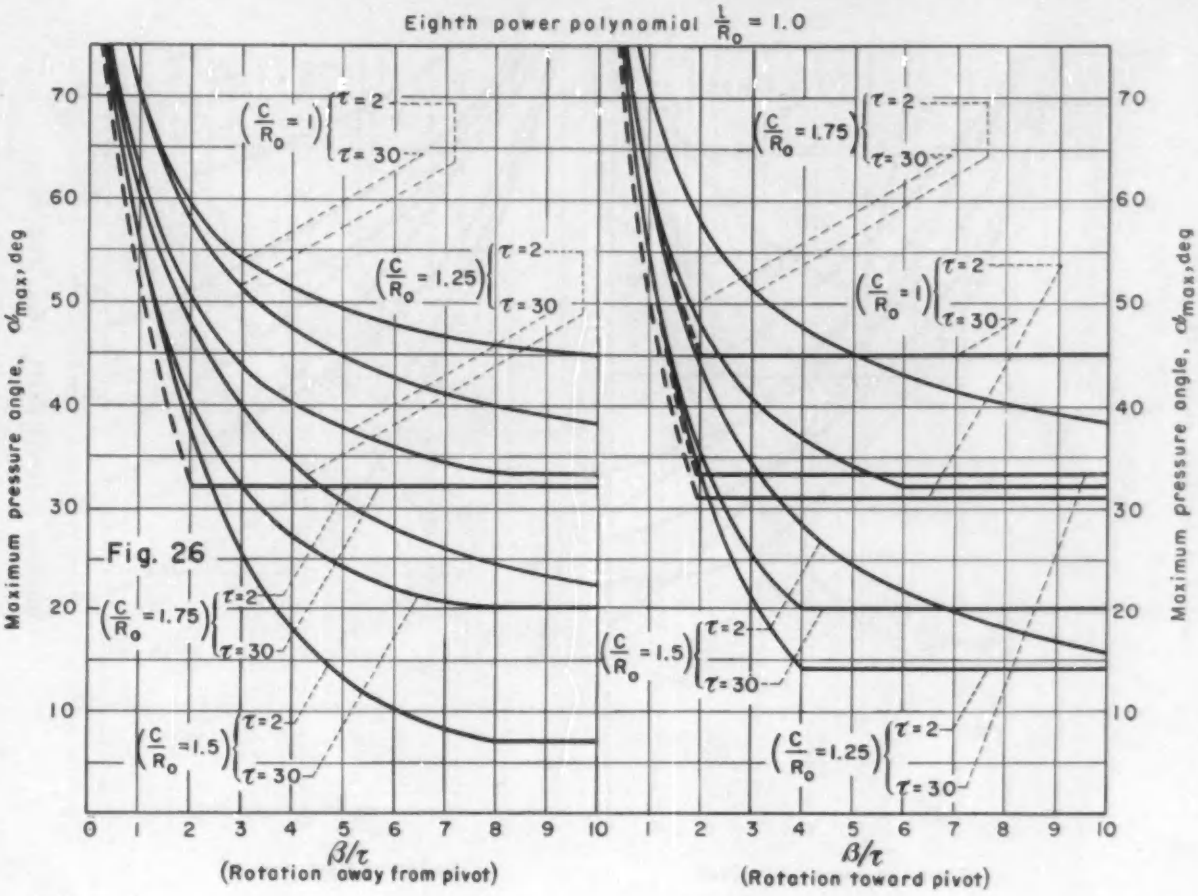

Eighth power polynomial $\frac{1}{R_0} = 1.0$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 1\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.25\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.75\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.5\right)\{\tau = 2, \tau = 30$
β/τ
(Rotation away from pivot)
$\left(\frac{C}{R_0} = 1.75\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.5\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.25\right)\{\tau = 2, \tau = 30$
β/τ
(Rotation toward pivot)
Maximum pressure angle, α_{max}, deg

Fig. 26

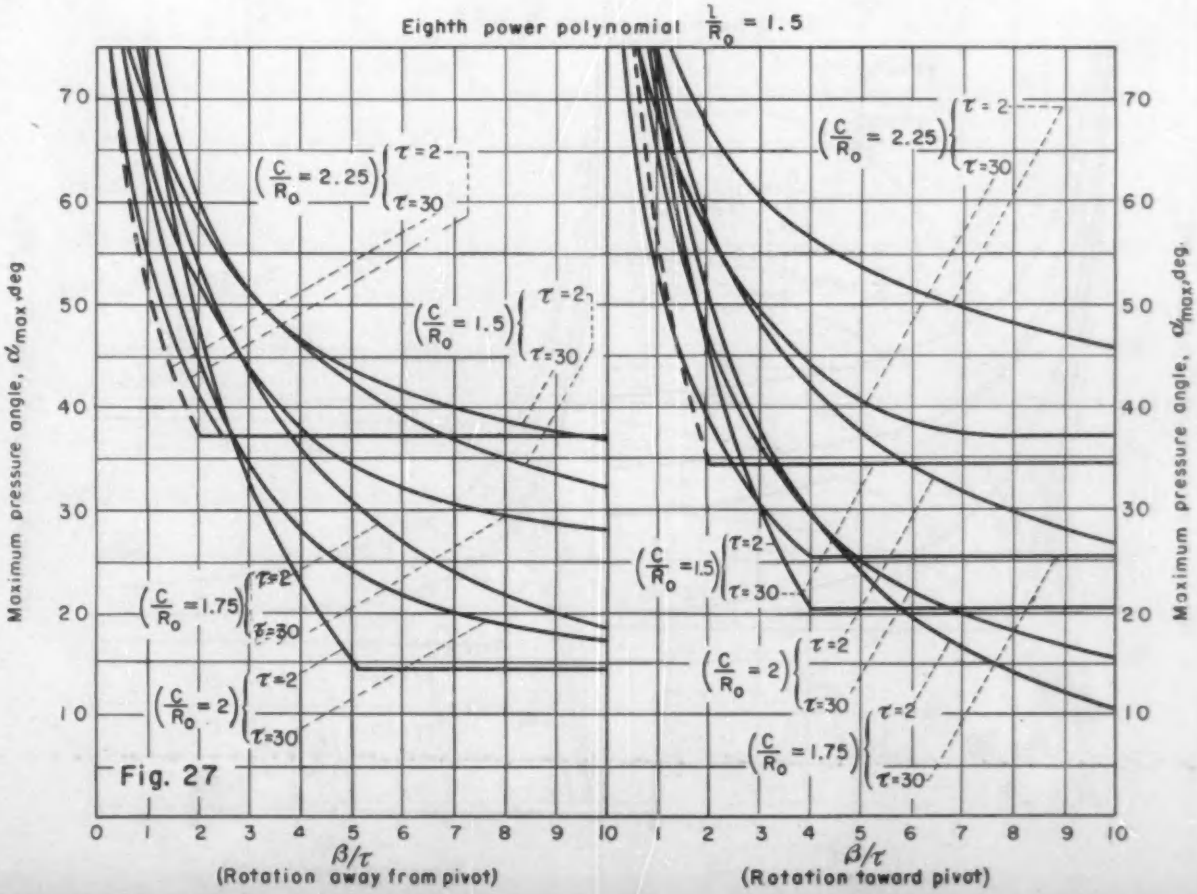
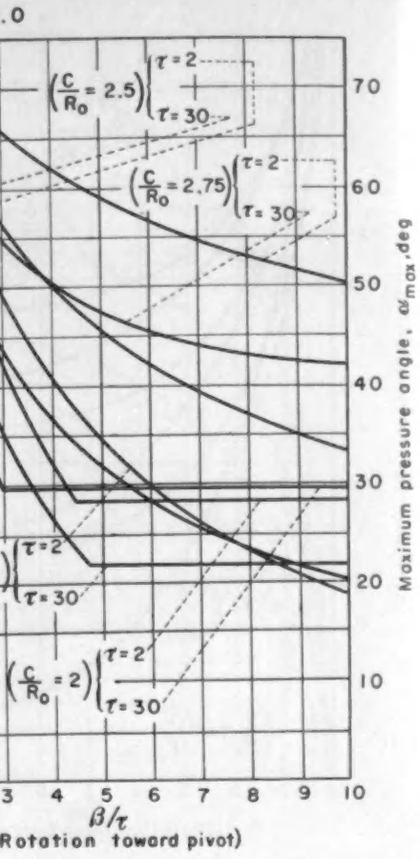
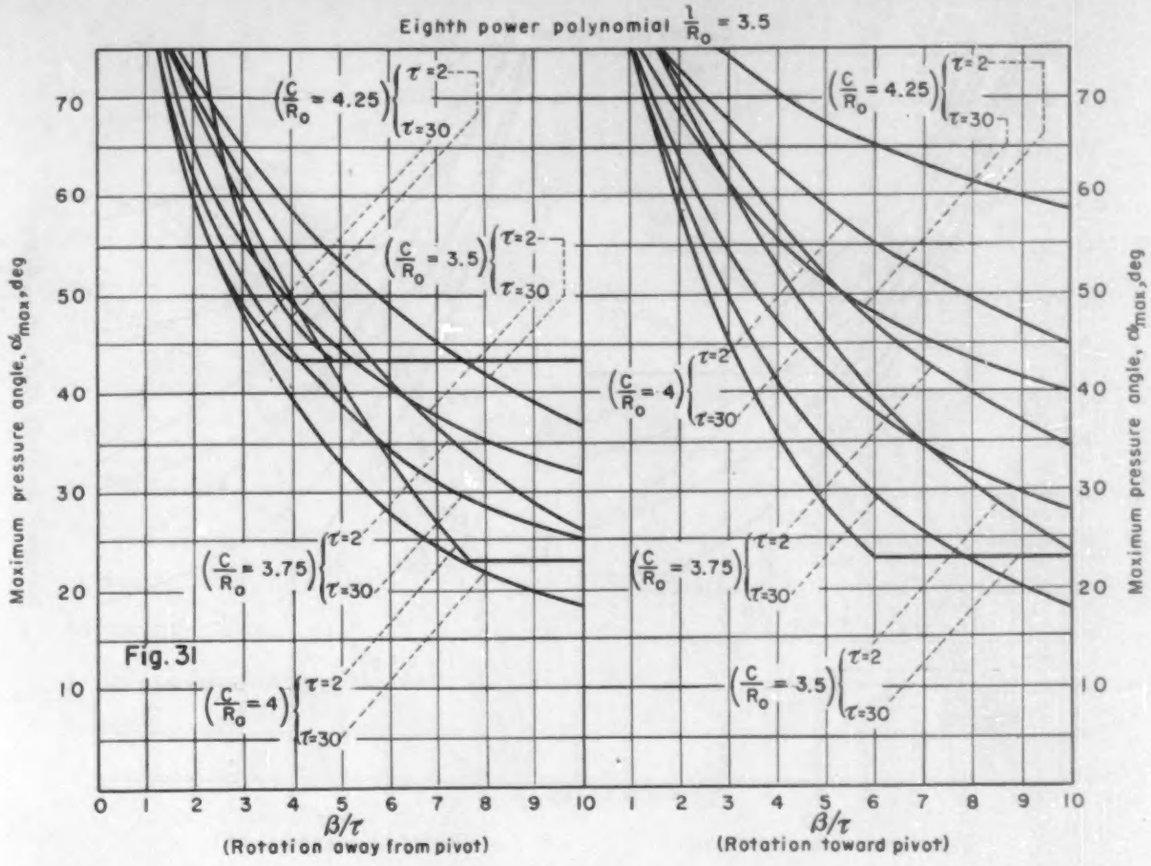
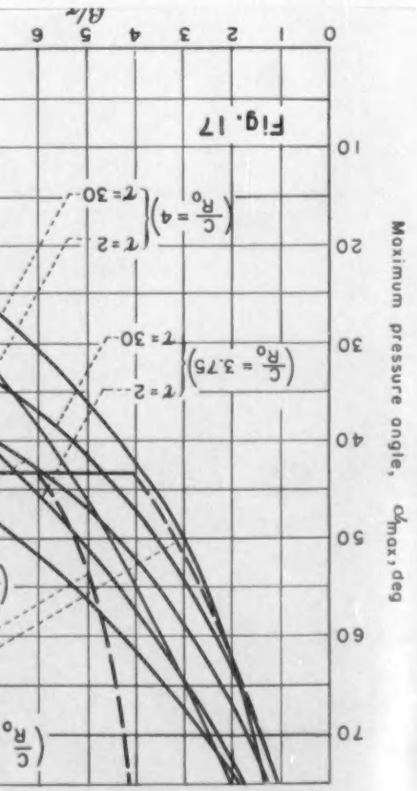
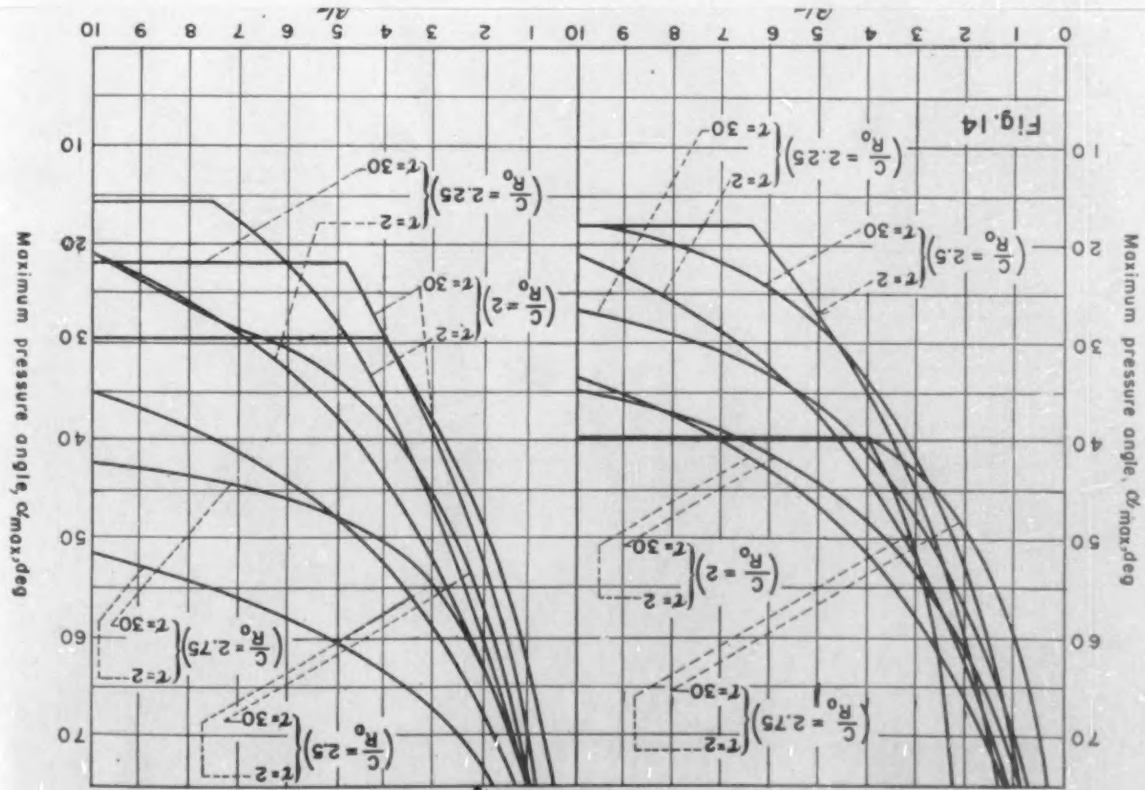

Eighth power polynomial $\frac{1}{R_0} = 1.5$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 2.25\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.5\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.75\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 2\right)\{\tau = 2, \tau = 30$
β/τ
(Rotation away from pivot)
$\left(\frac{C}{R_0} = 2.25\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.5\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 2\right)\{\tau = 2, \tau = 30$
$\left(\frac{C}{R_0} = 1.75\right)\{\tau = 2, \tau = 30$
β/τ
(Rotation toward pivot)
Maximum pressure angle, α_{max}, deg

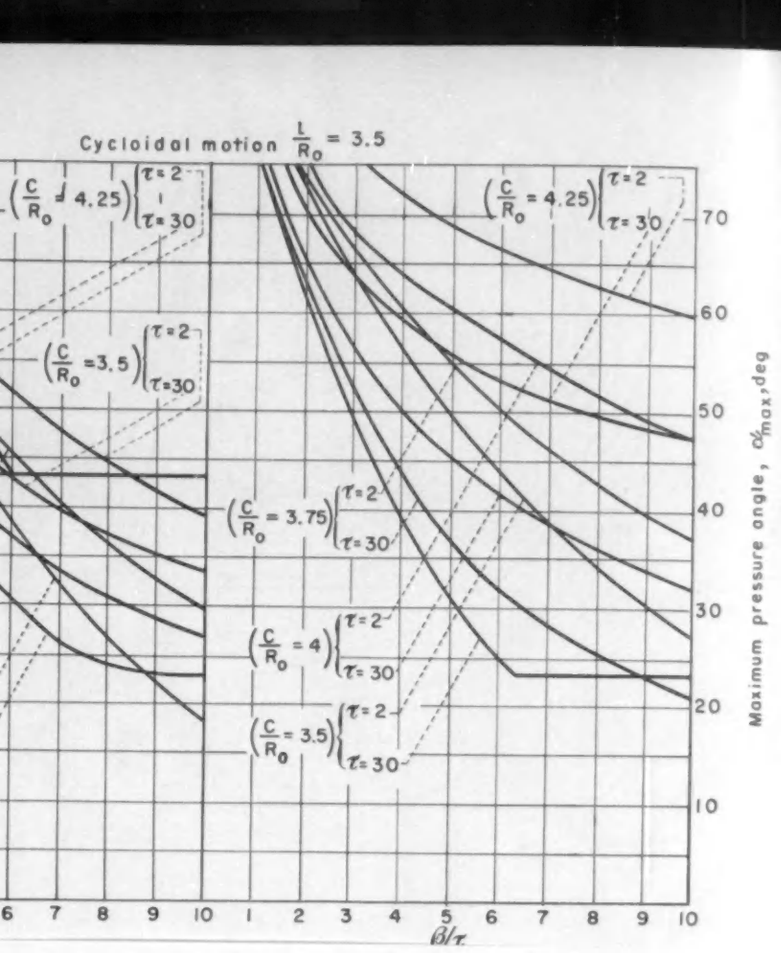
Fig. 27

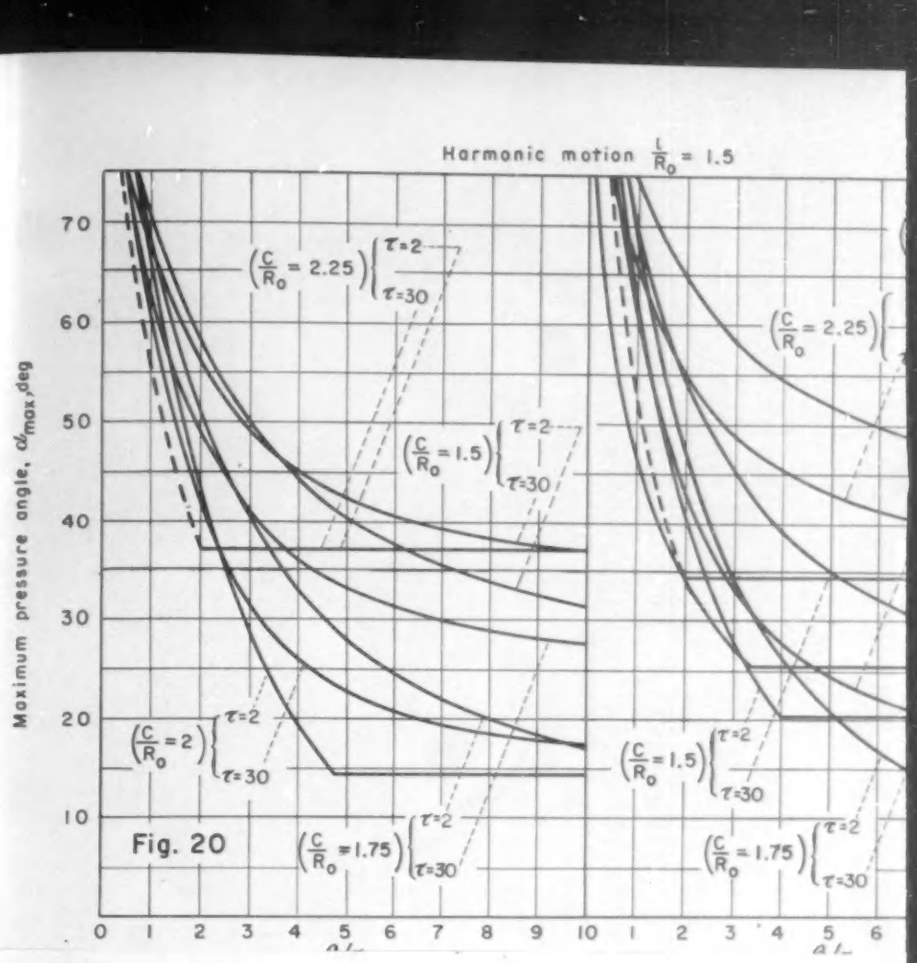

.0
$\left(\frac{C}{R_o}=2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max},deg
10 20 30 40 50 60 70
3 4 5 6 7 8 9 10
β/τ
Rotation toward pivot)

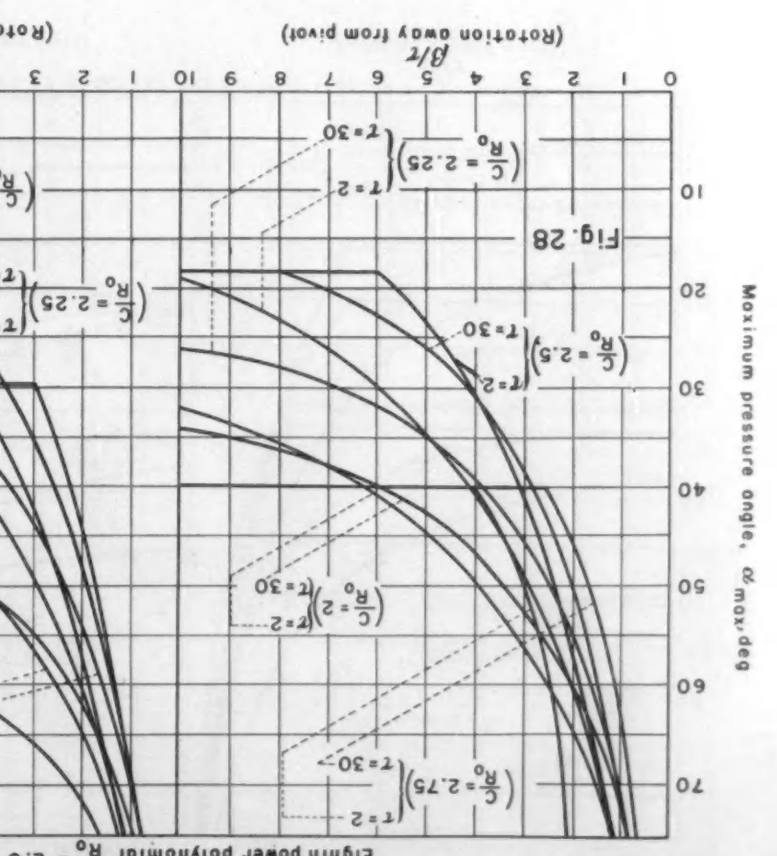

Eighth power polynomial $\frac{1}{R_o}=3.5$
$\left(\frac{C}{R_o}=4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 31
Maximum pressure angle, α_{max},deg
10 20 30 40 50 60 70
0 1 2 3 4 5 6 7 8 9 10
β/τ
(Rotation away from pivot)
(Rotation toward pivot)

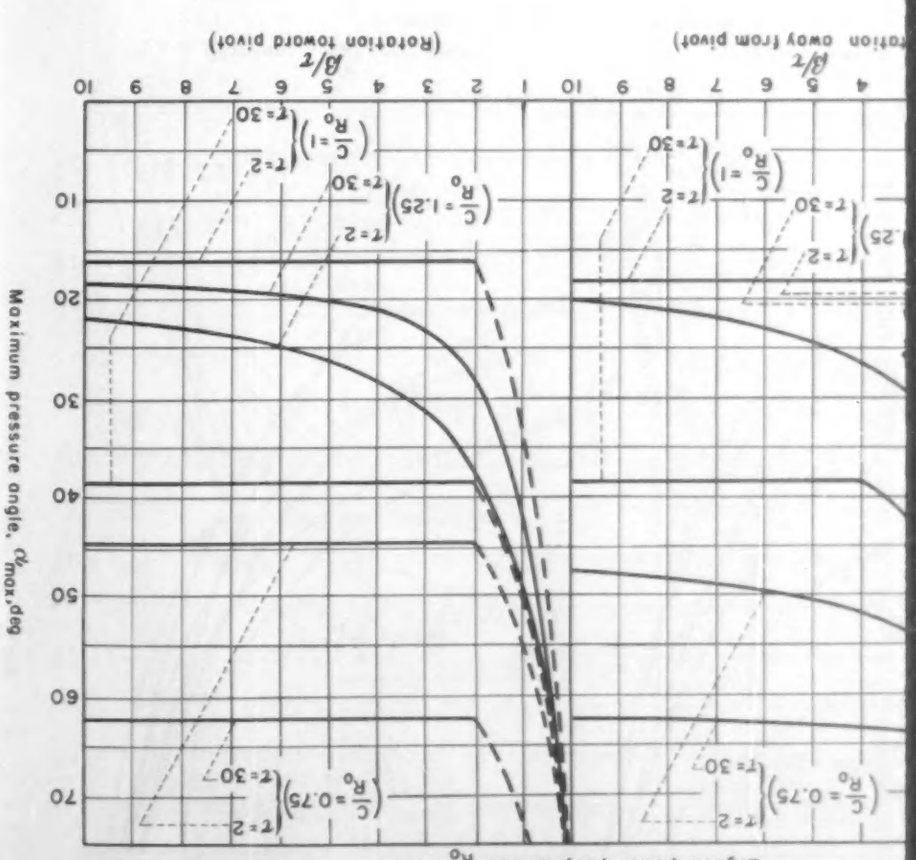

$\left(\frac{C}{R_o}=4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 17
Maximum pressure angle, α_{max},deg
10 20 30 40 50 60 70
0 1 2 3 4 5 6
Δ/ϵ

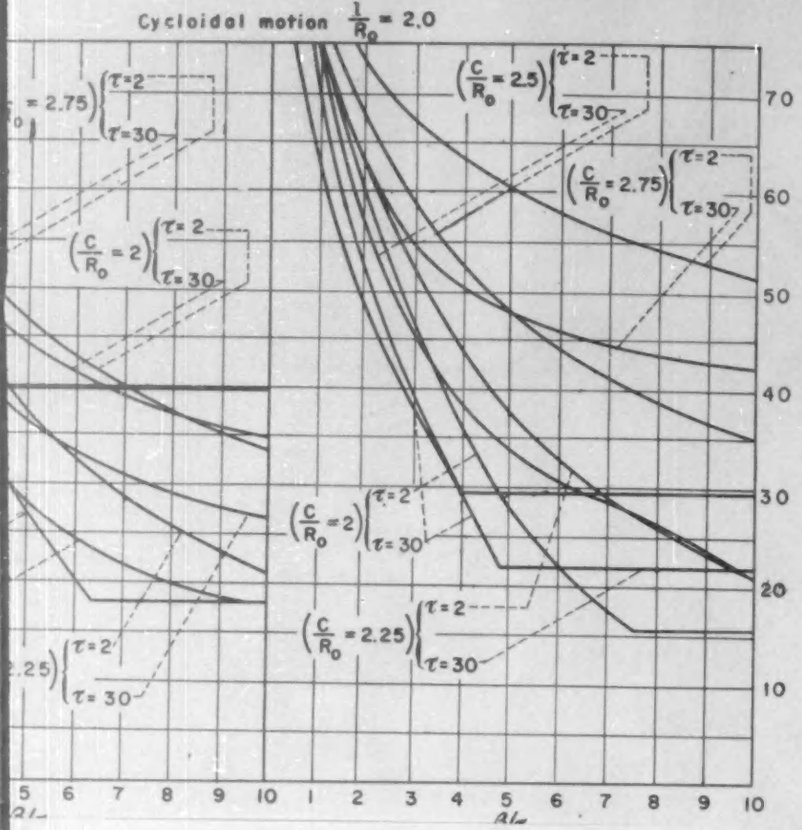

Cycloidal motion $\frac{1}{R_o}=2.0$
$\left(\frac{C}{R_o}=2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 14
Maximum pressure angle, α_{max},deg
10 20 30 40 50 60 70
0 1 2 3 4 5 6 7 8 9 10
Δ/ϵ


Cycloidal motion $\frac{L}{R_o} = 3.5$
$\left(\frac{C}{R_o} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ


Harmonic motion $\frac{L}{R_o} = 1.5$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
Fig. 20


Eighth power polynomial $\frac{L}{R_o} = 2.0$
$\left(\frac{C}{R_o} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
Fig. 28


Eighth power polynomial $\frac{L}{R_o} = 0.5$
$\left(\frac{C}{R_o} = 0.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation toward pivot)
(Rotation away from pivot)



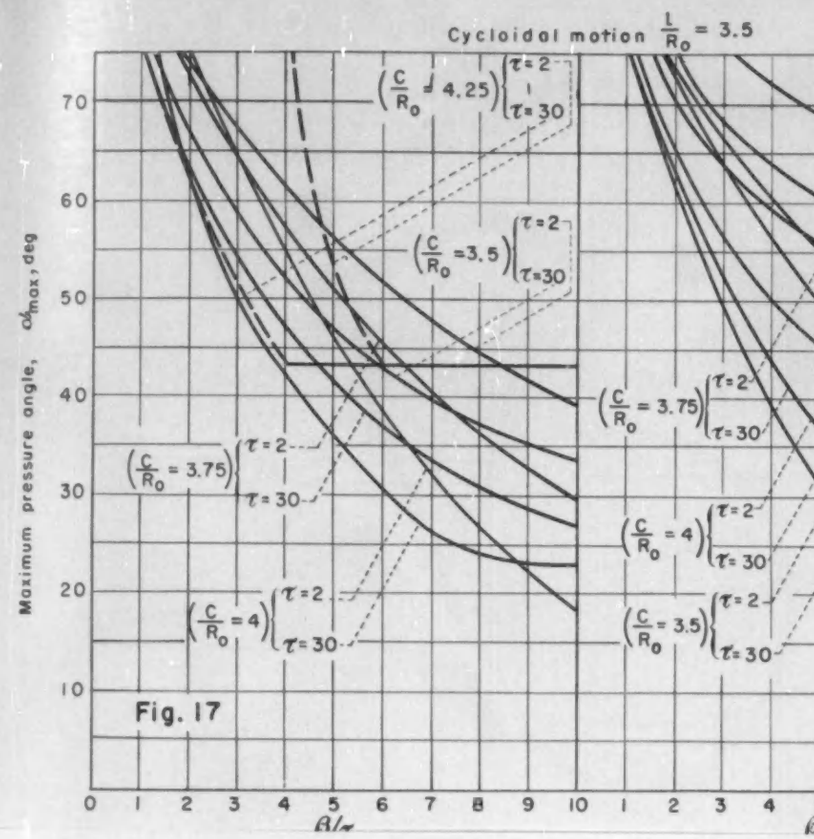
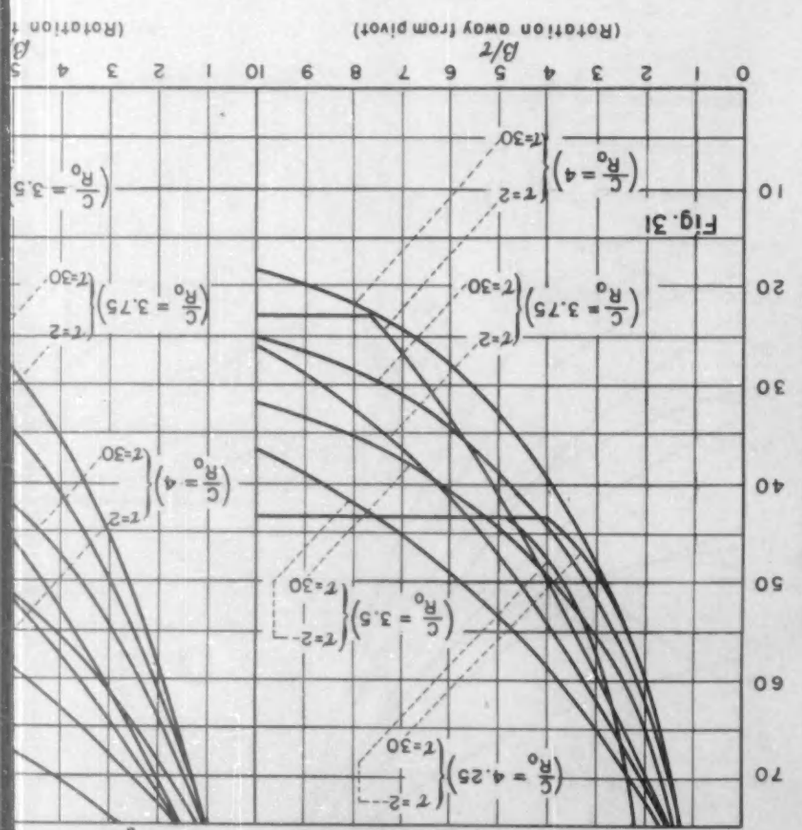
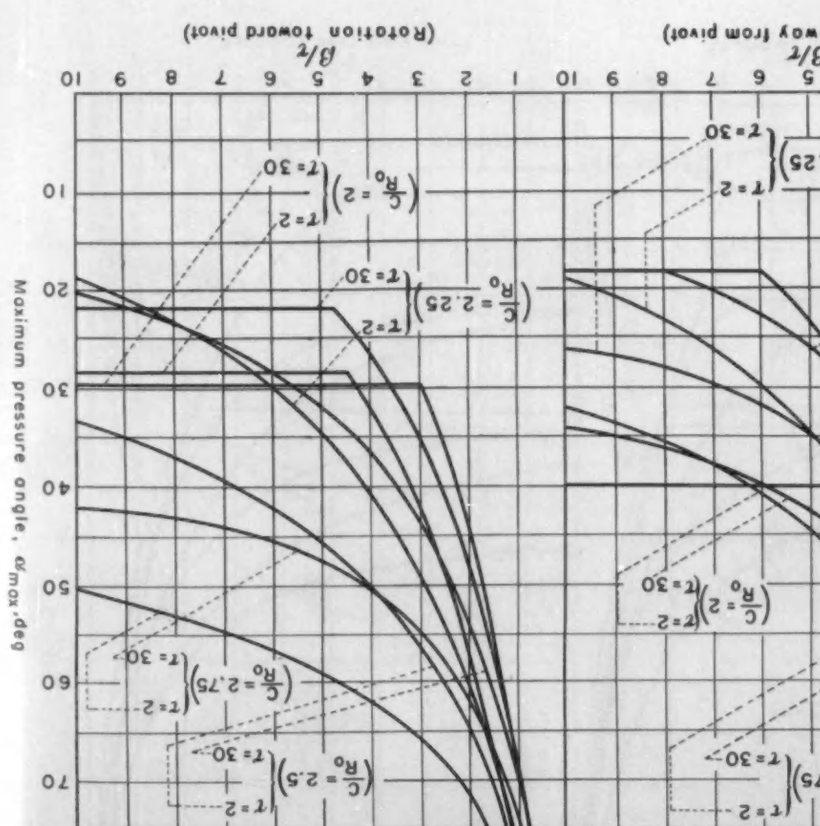

Cycloidal motion $\frac{l}{R_o} = 3.5$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$

Fig. 17



Eighth power polynomial $\frac{l}{R_o} = 3.5$



Eighth power polynomial $\frac{l}{R_o} = 2.0$

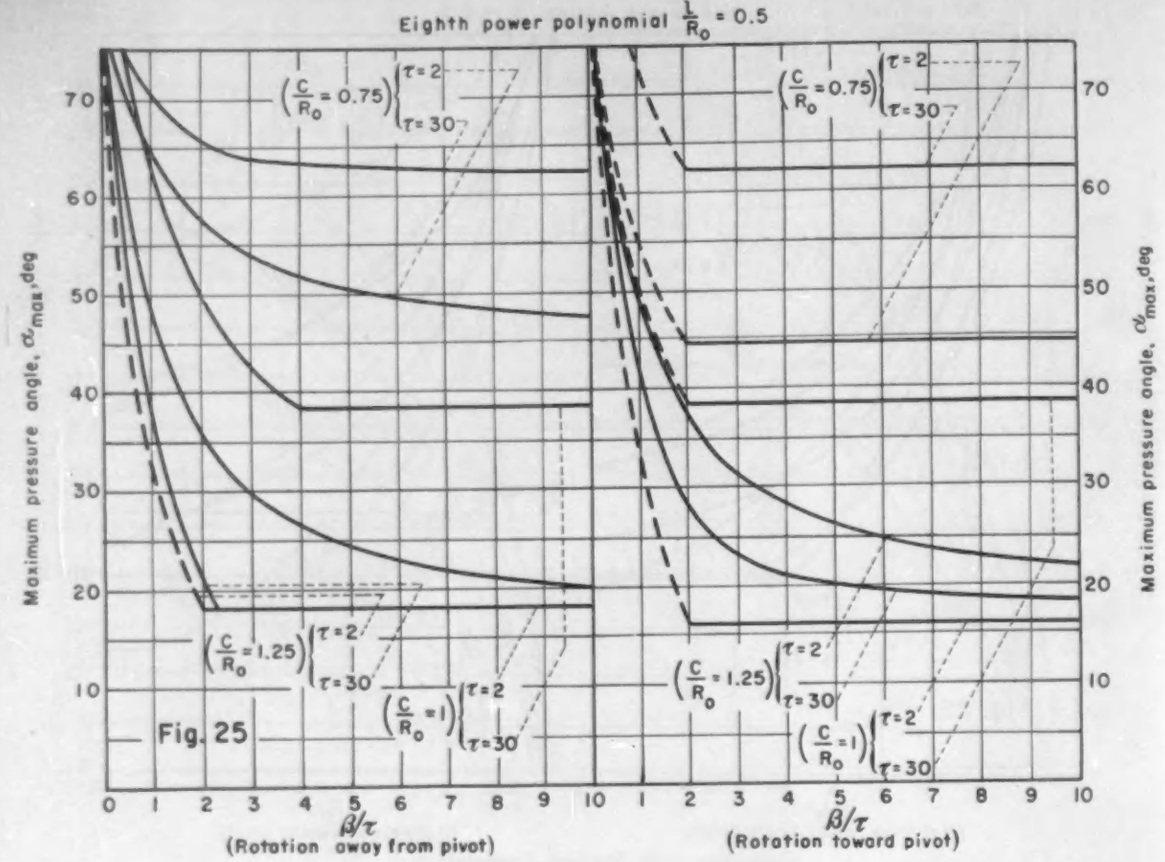


Fig. 25

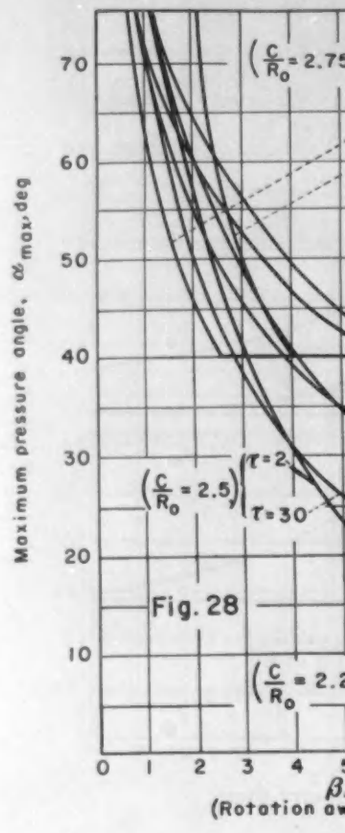


Fig. 28

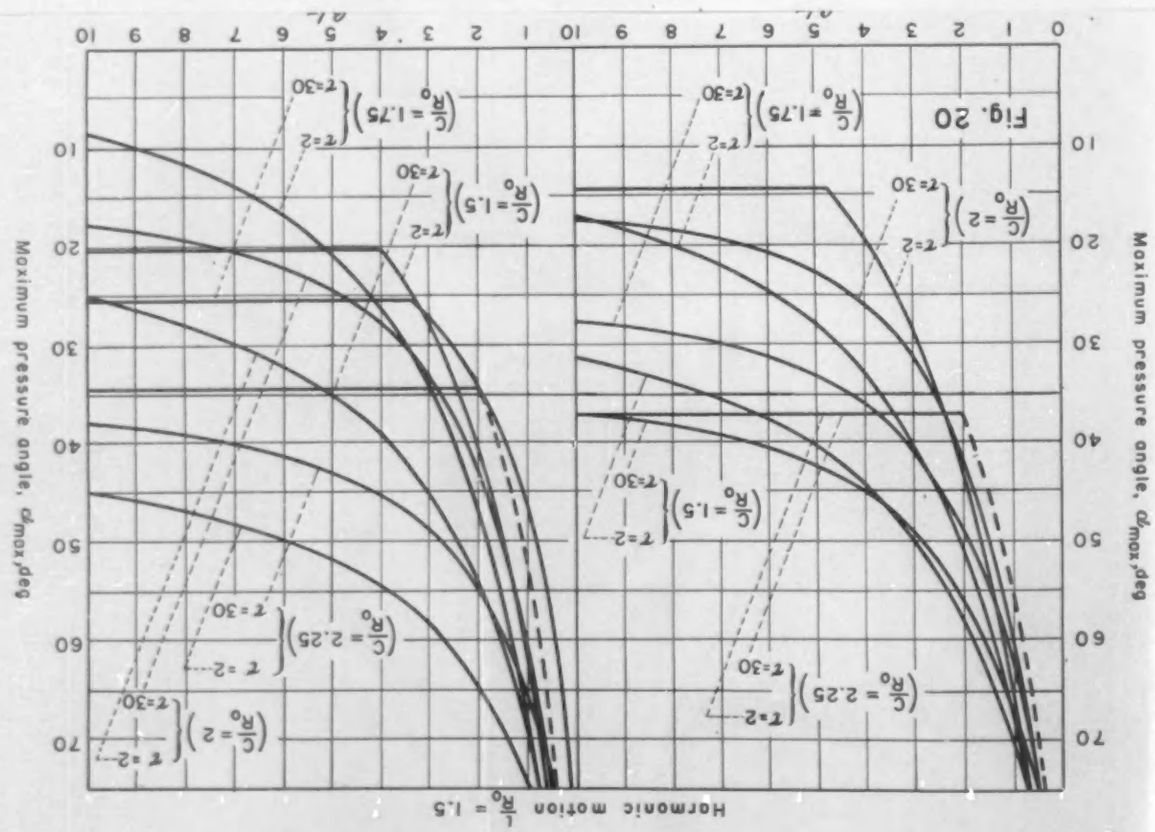
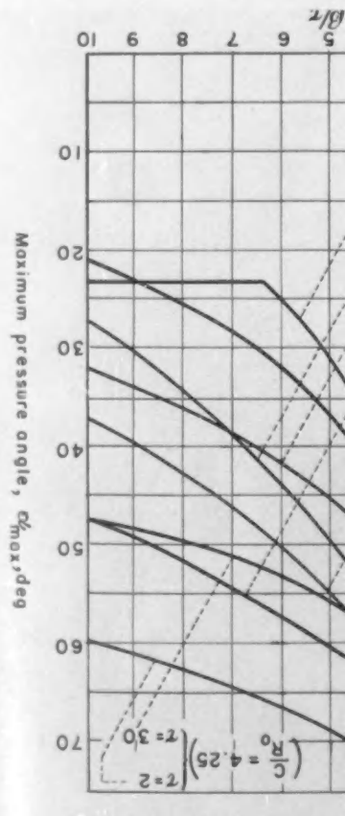
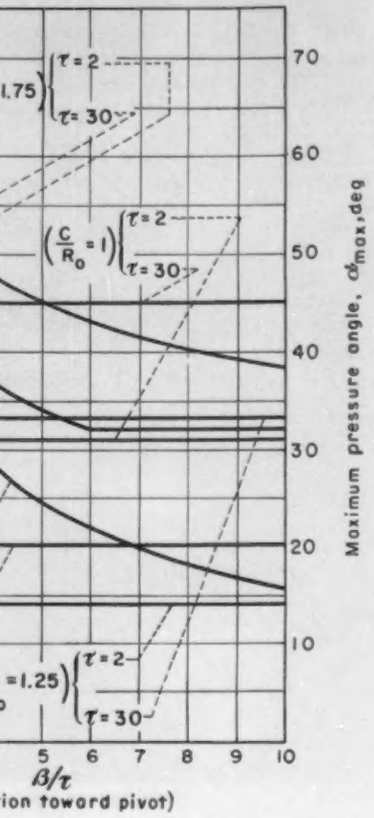
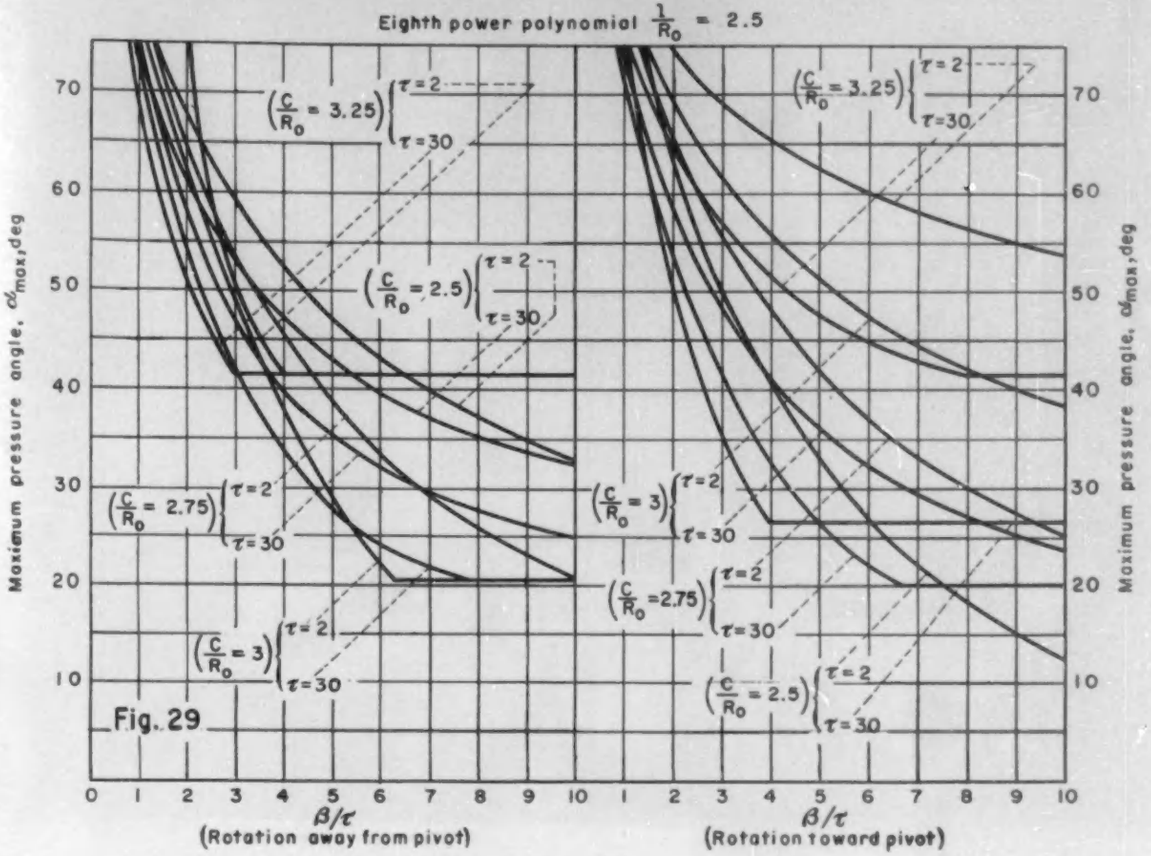
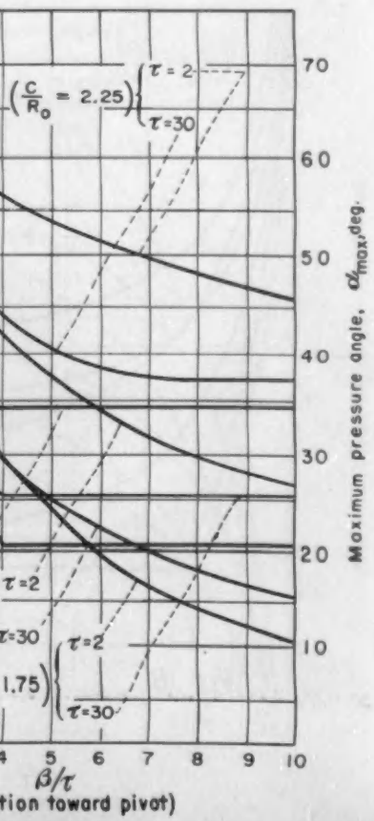

Harmonic motion $\frac{l}{R_o} = 1.5$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$

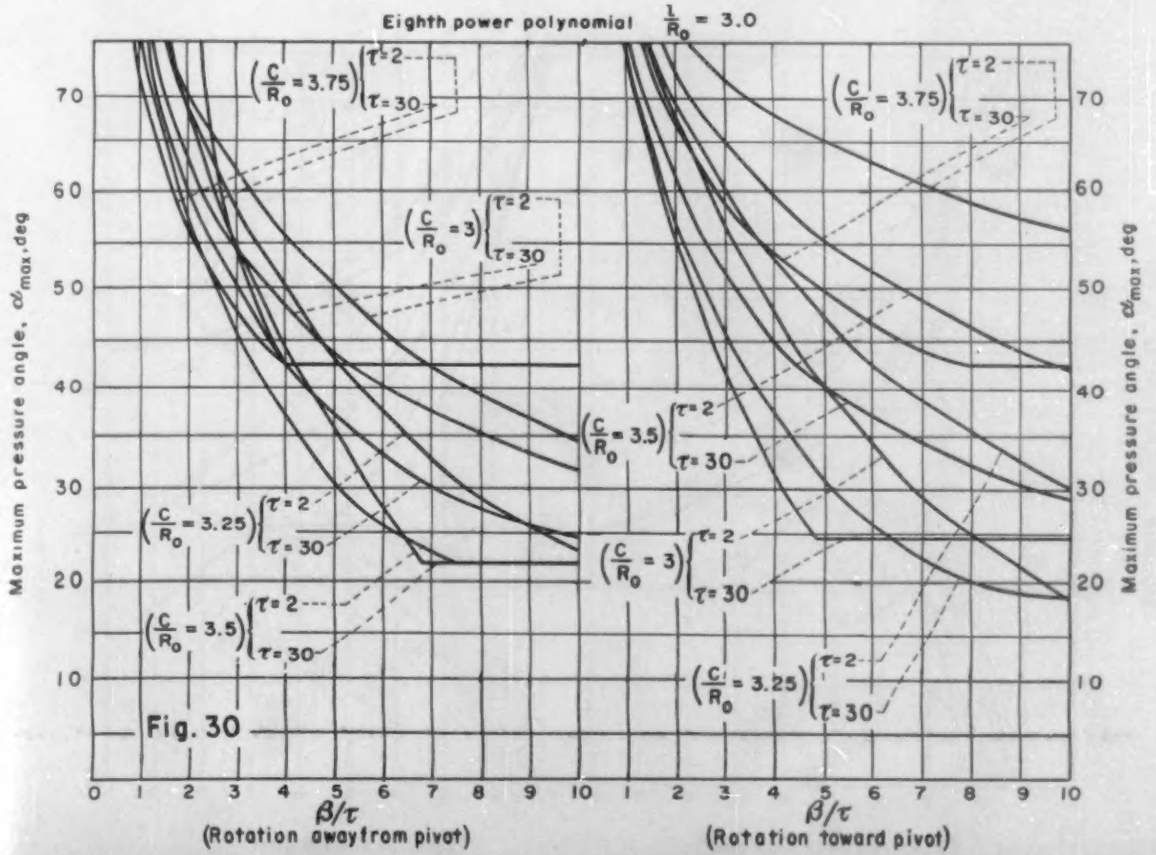
Fig. 20

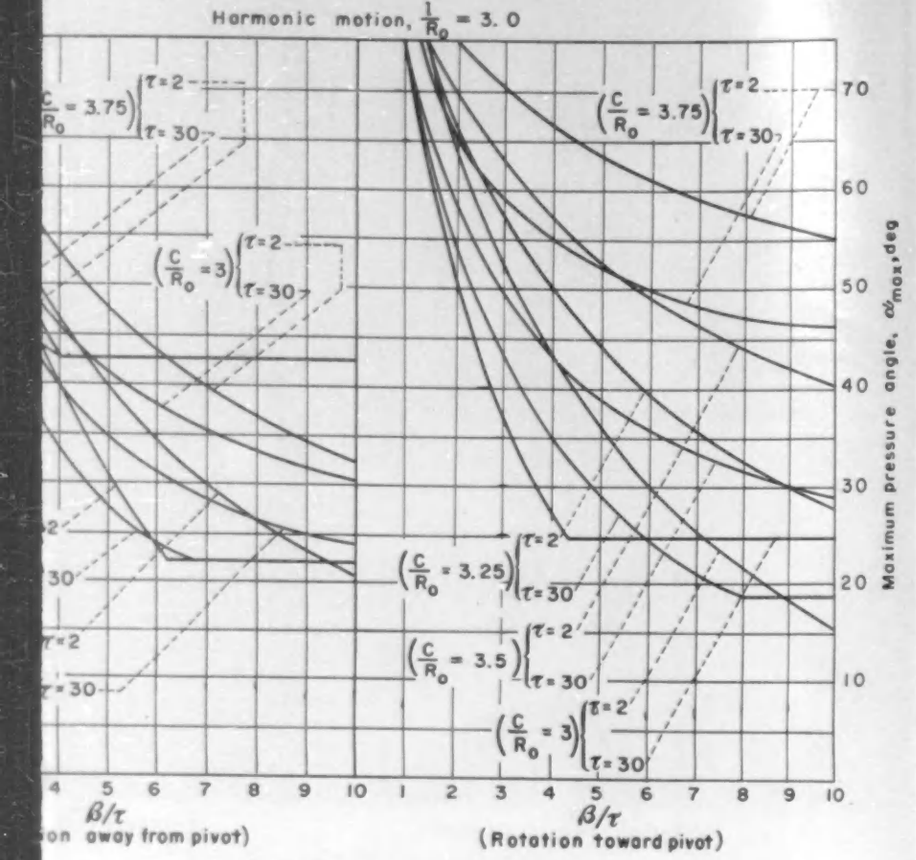


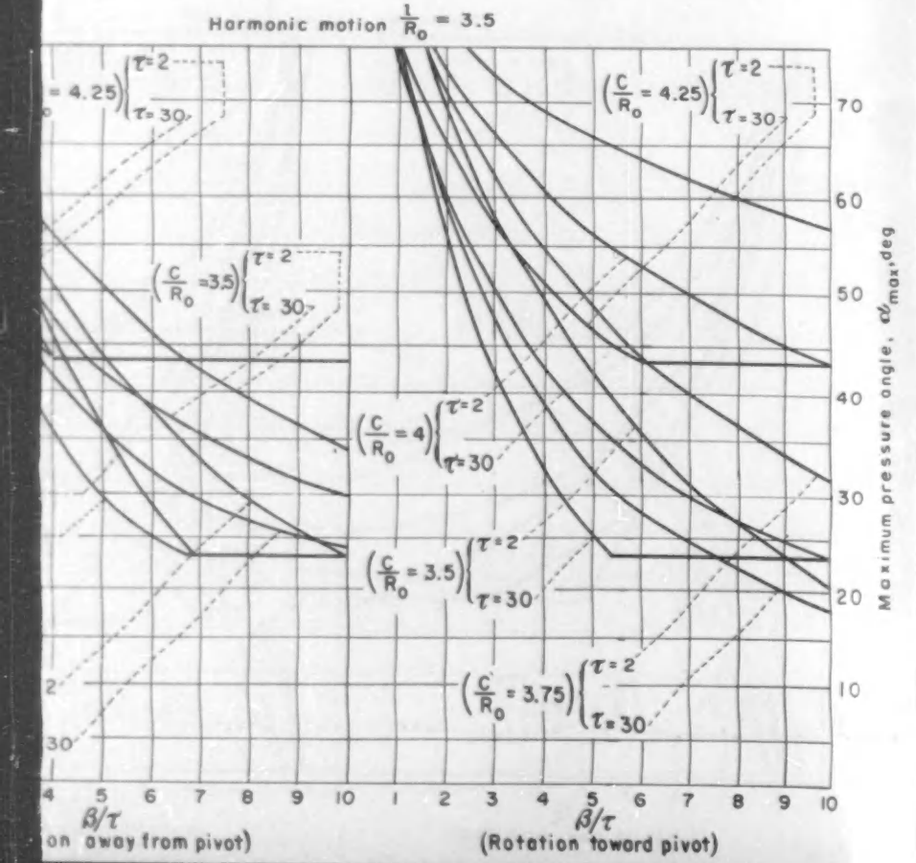

1.75
τ = 2
τ = 30
(C/R0 = 1)
τ = 2
τ = 30
=1.25)
τ = 2
τ = 30
70
60
50
40
30
20
10
Maximum pressure angle, αmax,deg
5 6 7 8 9 10
β/τ
ion toward pivot)


Eighth power polynomial 1/R0 = 2.5
(C/R0 = 3.25) τ = 2 τ = 30
(C/R0 = 2.5) τ = 2 τ = 30
(C/R0 = 2.75) τ = 2 τ = 30
(C/R0 = 3) τ = 2 τ = 30
(C/R0 = 3.25) τ = 2 τ = 30
(C/R0 = 2.75) τ = 2 τ = 30
(C/R0 = 3) τ = 2 τ = 30
(C/R0 = 2.5) τ = 2 τ = 30
Fig. 29
Maximum pressure angle, αmax,deg
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10
β/τ
(Rotation away from pivot)
β/τ
(Rotation toward pivot)


(C/R0 = 2.25) τ = 2 τ = 30
τ=2
τ=30
1.75) τ=2 τ=30
70
60
50
40
30
20
10
Maximum pressure angle, αmax,deg.
4 5 6 7 8 9 10
β/τ
tion toward pivot)


Eighth power polynomial 1/R0 = 3.0
(C/R0 = 3.75) τ = 2 τ = 30
(C/R0 = 3) τ = 2 τ = 30
(C/R0 = 3.25) τ = 2 τ = 30
(C/R0 = 3.5) τ = 2 τ = 30
(C/R0 = 3.75) τ = 2 τ = 30
(C/R0 = 3.5) τ = 2 τ = 30
(C/R0 = 3) τ = 2 τ = 30
(C/R0 = 3.25) τ = 2 τ = 30
Fig. 30
Maximum pressure angle, αmax,deg
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10
β/τ
(Rotation away from pivot)
β/τ
(Rotation toward pivot)


Harmonic motion, $\frac{1}{R_0} = 3.0$
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation toward pivot)


Harmonic motion $\frac{1}{R_0} = 3.5$
$\left(\frac{C}{R_0} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation toward pivot)

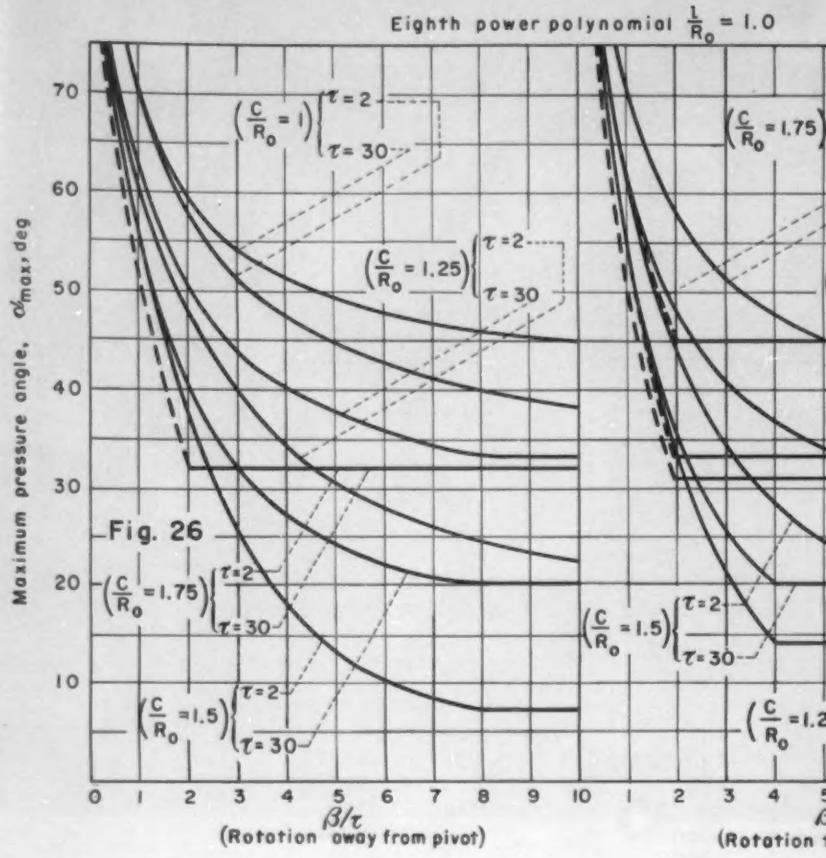

Eighth power polynomial $\frac{1}{R_0} = 1.0$
$\left(\frac{C}{R_0} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)

Fig. 26

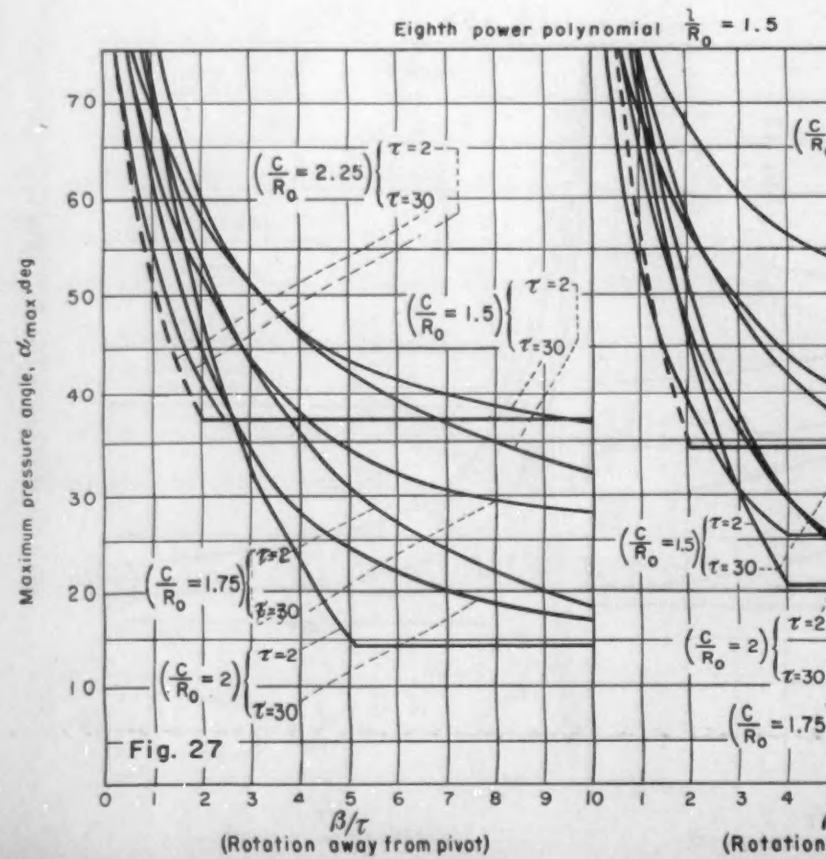
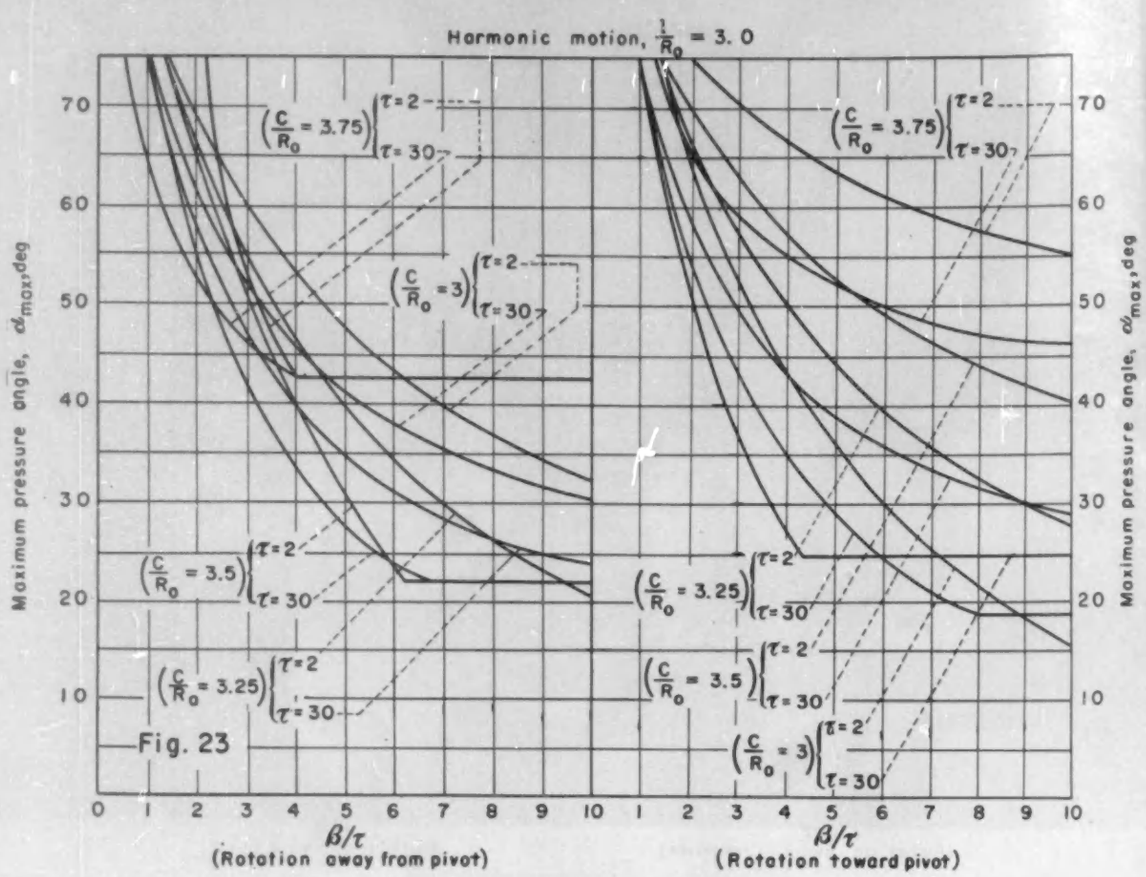
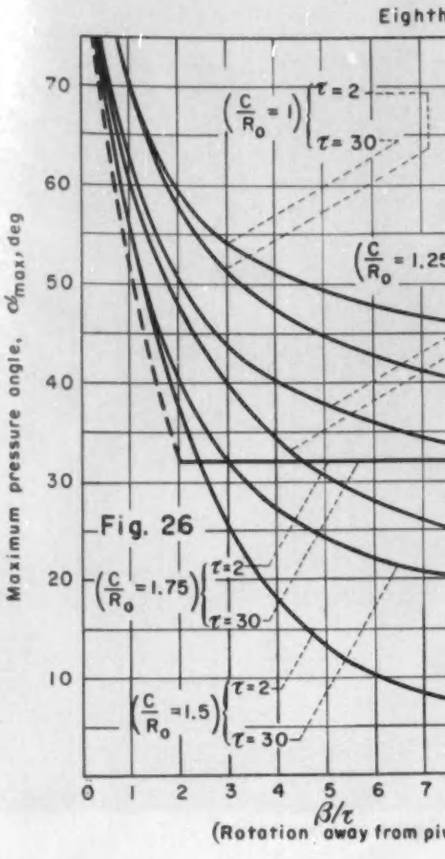
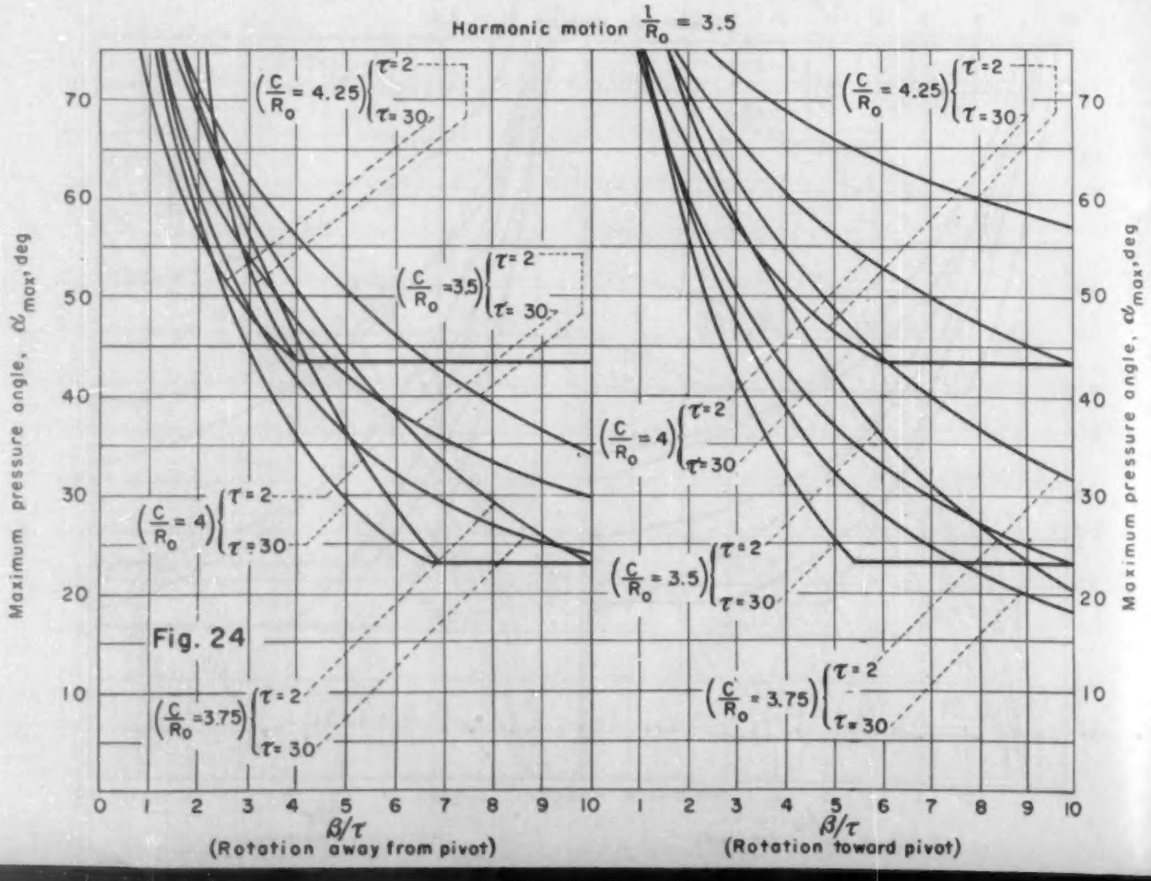
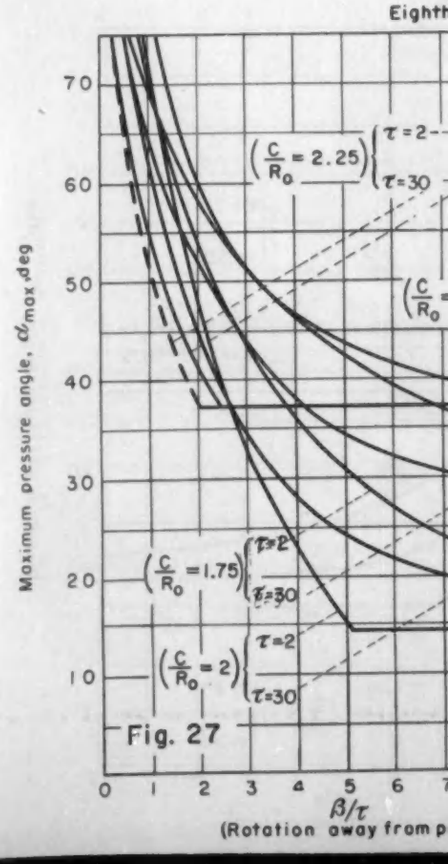

Eighth power polynomial $\frac{1}{R_0} = 1.5$
$\left(\frac{C}{R_0} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)

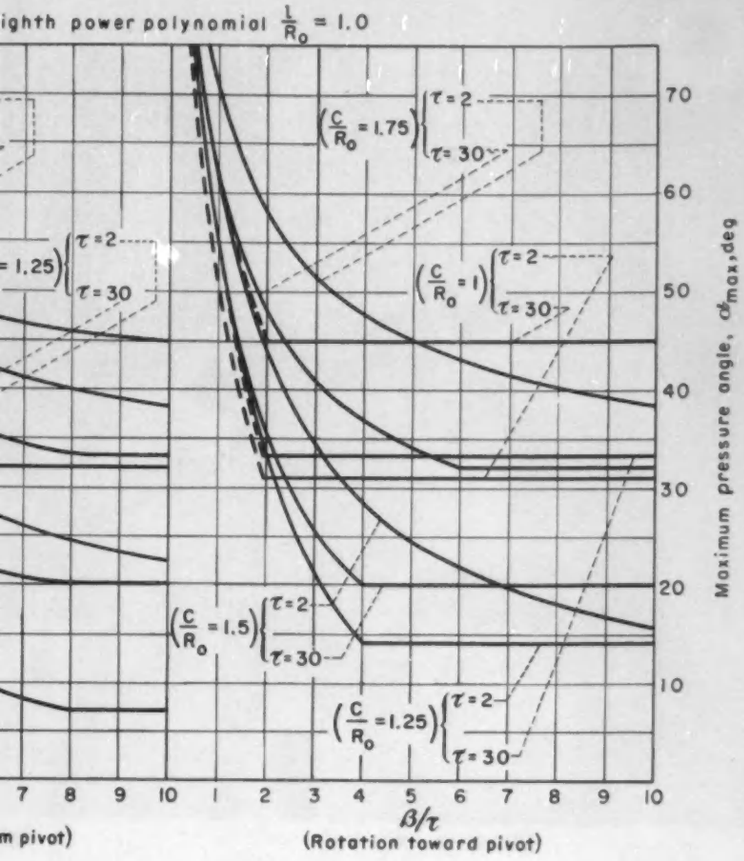
Fig. 27

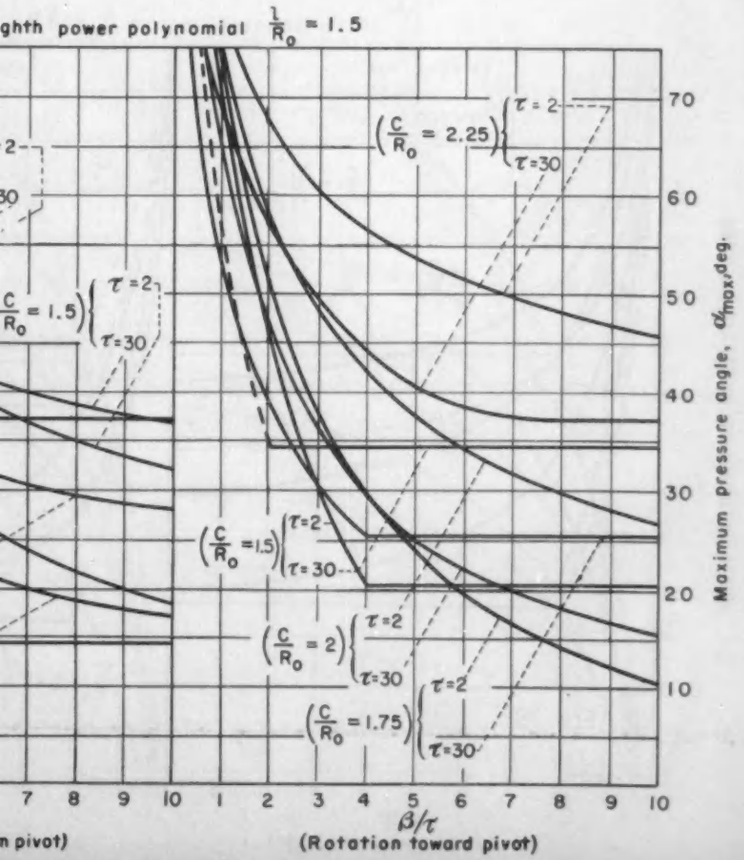

Harmonic motion, $\frac{1}{R_0} = 3.0$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 23
β/τ
(Rotation away from pivot)
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
β/τ
(Rotation toward pivot)


Eighth
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.25\right)$
Fig. 26
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
β/τ
(Rotation away from pi


Harmonic motion $\frac{1}{R_0} = 3.5$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 24
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
β/τ
(Rotation away from pivot)
$\left(\frac{C}{R_0} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
β/τ
(Rotation toward pivot)


Eighth
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 27
β/τ
(Rotation away from p


ighth power polynomial $\frac{l}{R_0} = 1.0$
$\left(\frac{C}{R_0}=1.75\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=1.25\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=1\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=1.5\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=1.25\right)\{\tau=2,\ \tau=30$
Maximum pressure angle, α_{max}, deg
70
60
50
40
30
20
10
7 8 9 10 1 2 3 4 5 6 7 8 9 10
β/τ
m pivot)
(Rotation toward pivot)


ghth power polynomial $\frac{l}{R_0} = 1.5$
$\left(\frac{C}{R_0}=2.25\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=1.5\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=1.5\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=2\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=1.75\right)\{\tau=2,\ \tau=30$
Maximum pressure angle, α_{max}, deg.
70
60
50
40
30
20
10
7 8 9 10 1 2 3 4 5 6 7 8 9 10
β/τ
n pivot)
(Rotation toward pivot)

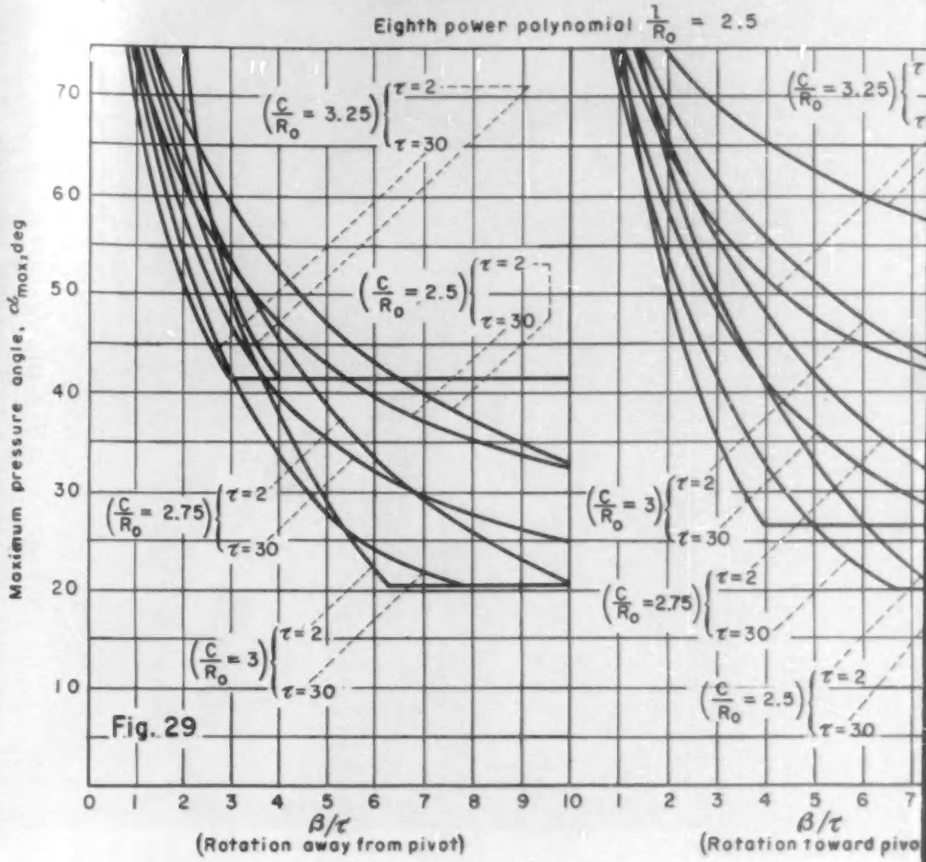

Eighth power polynomial $\frac{l}{R_0} = 2.5$
$\left(\frac{C}{R_0}=3.25\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=2.5\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=2.75\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=2.75\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=2.5\right)\{\tau=2,\ \tau=30$
Maximum pressure angle, α_{max}, deg
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7
β/τ
(Rotation away from pivot)
(Rotation toward pivo

Fig. 29

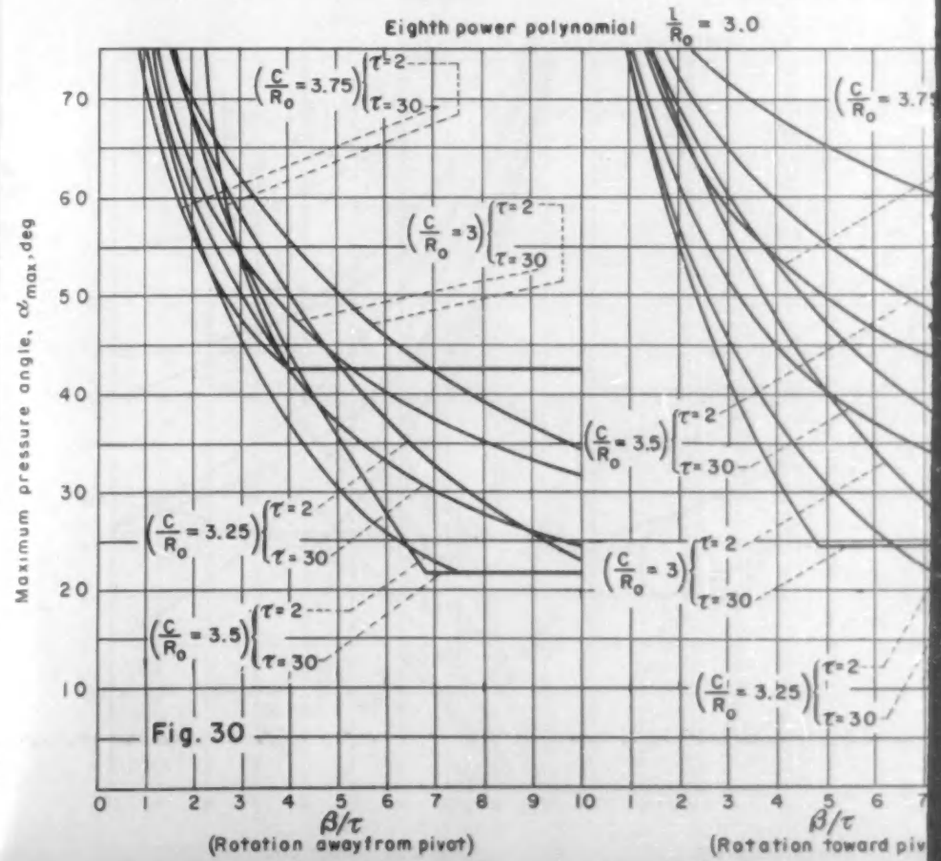
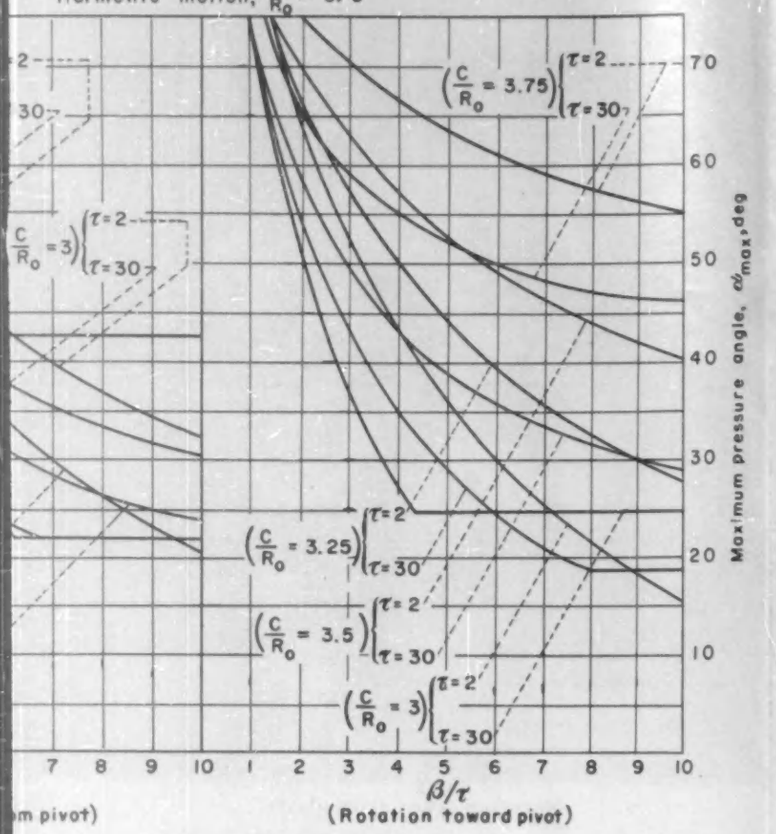
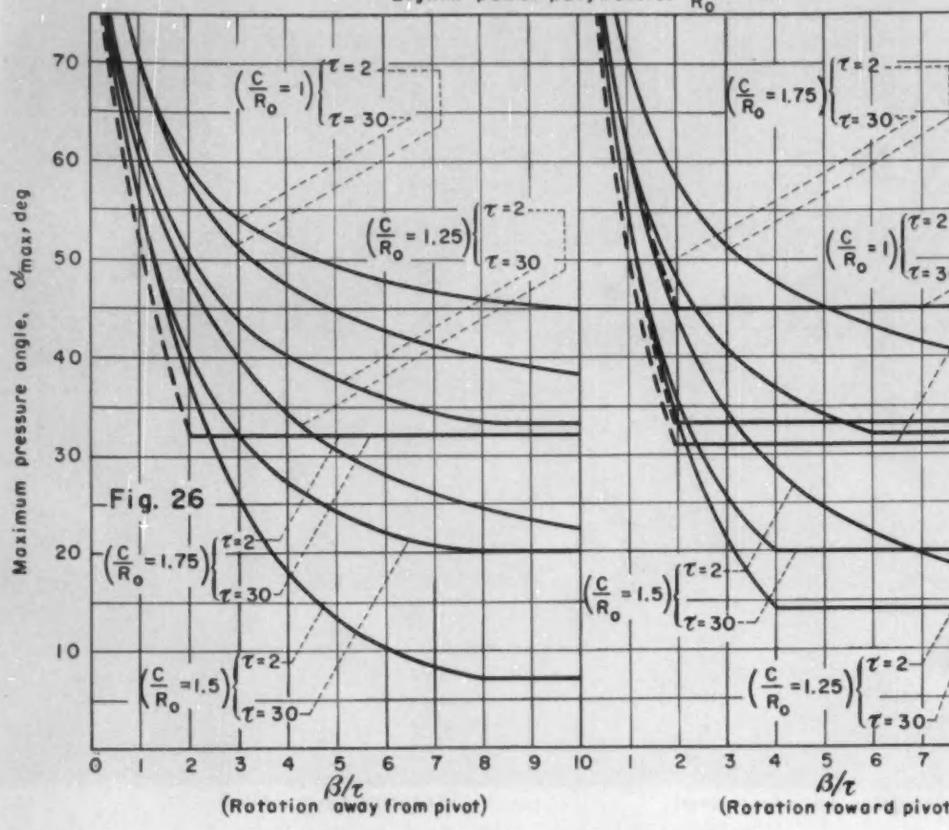
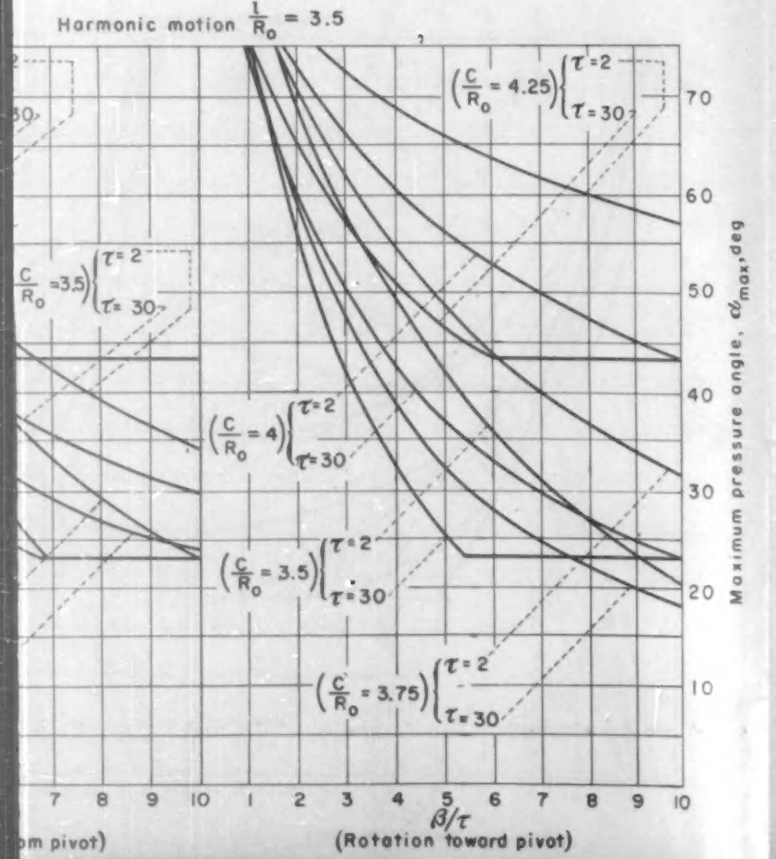
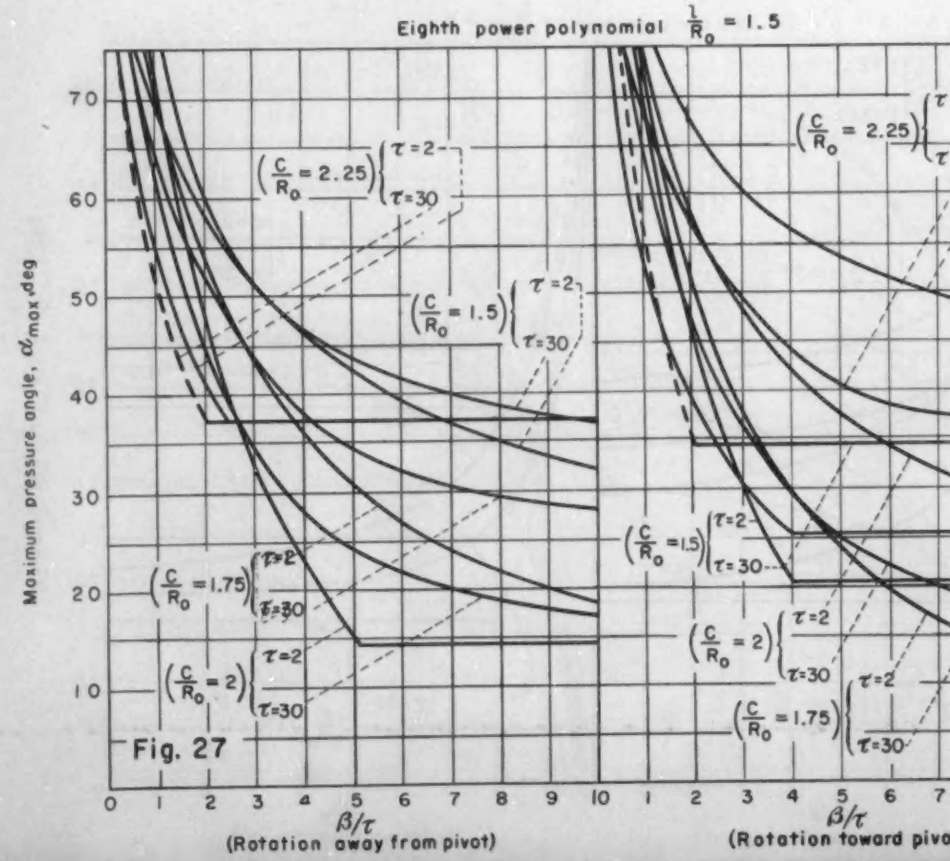

Eighth power polynomial $\frac{l}{R_0} = 3.0$
$\left(\frac{C}{R_0}=3.75\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3.5\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3.25\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3.5\right)\{\tau=2,\ \tau=30$
$\left(\frac{C}{R_0}=3.25\right)\{\tau=2,\ \tau=30$
Maximum pressure angle, α_{max}, deg
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7
β/τ
(Rotation away from pivot)
(Rotation toward piv

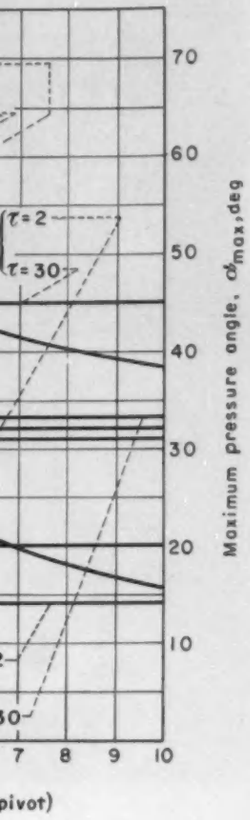
Fig. 30

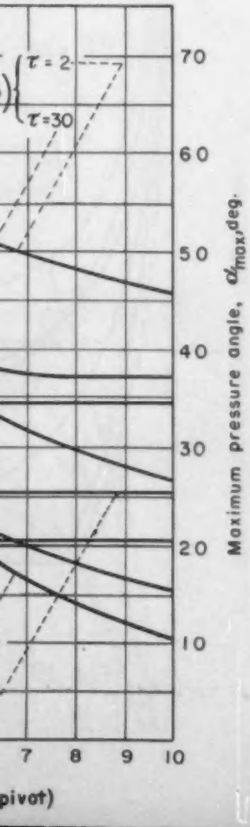

Harmonic motion, $\frac{1}{R_0} = 3.0$
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation toward pivot)

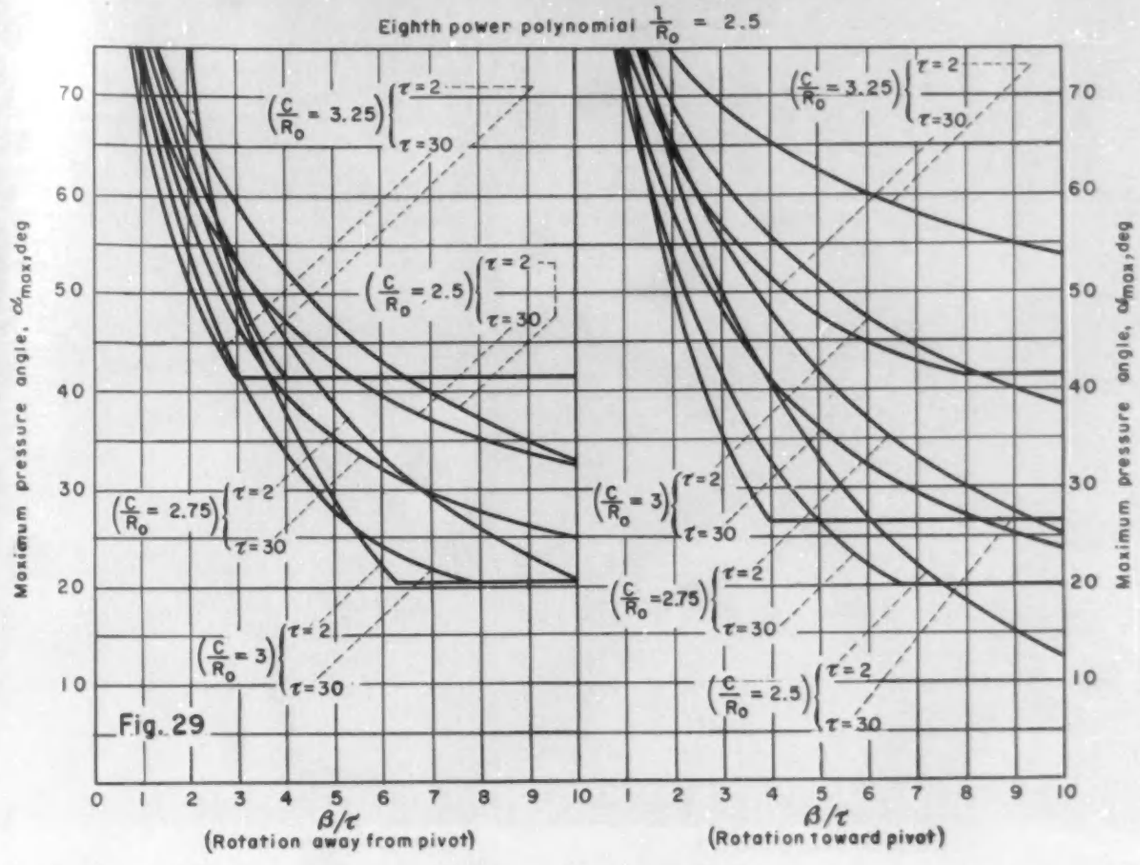

Eighth power polynomial $\frac{1}{R_0} = 1.0$
$\left(\frac{C}{R_0} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
Fig. 26
β/τ
(Rotation away from pivot)
(Rotation toward pivot)

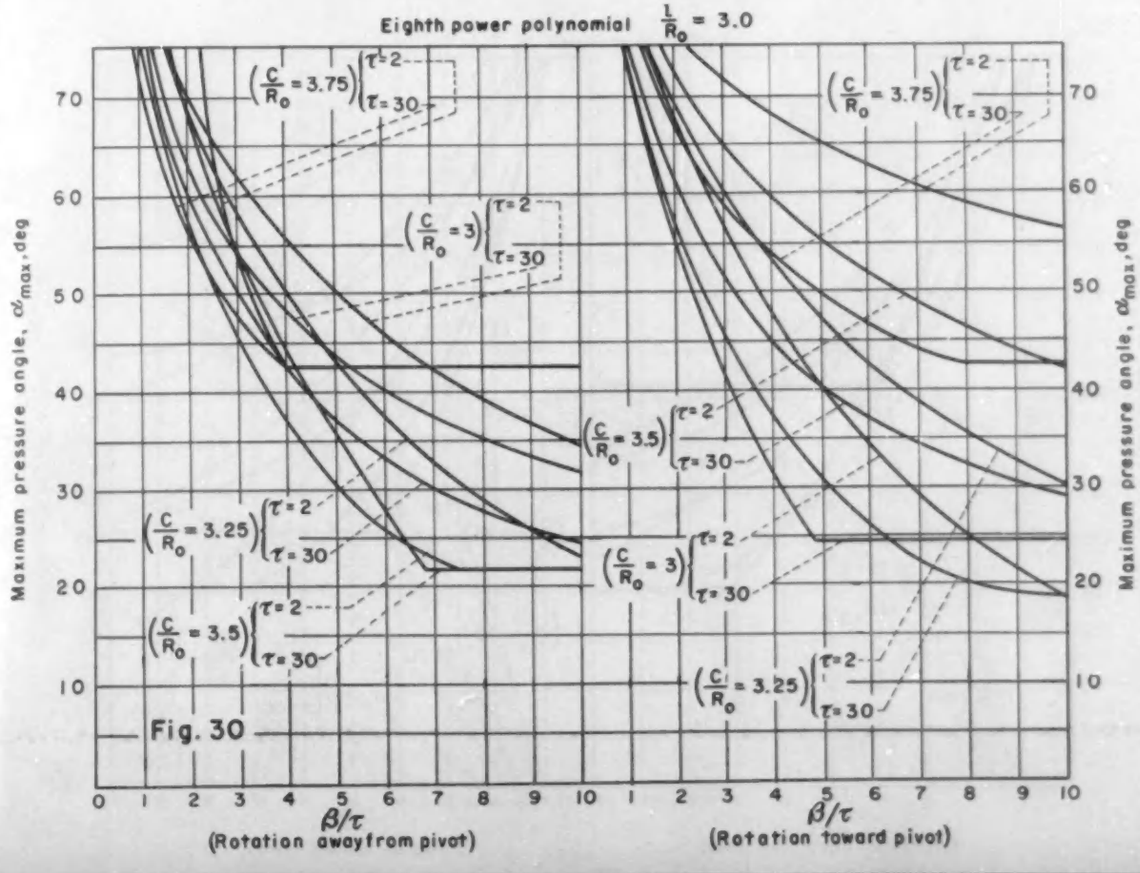

Harmonic motion $\frac{1}{R_0} = 3.5$
$\left(\frac{C}{R_0} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation toward pivot)


Eighth power polynomial $\frac{1}{R_0} = 1.5$
$\left(\frac{C}{R_0} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
Fig. 27
β/τ
(Rotation away from pivot)
(Rotation toward pivot)


70
60
50
40
30
20
10
τ=2
τ=30
7 8 9 10
pivot)


70
60
50
40
30
20
10
τ=2
τ=30
Maximum pressure angle, α_{max}, deg.
7 8 9 10
pivot)


Eighth power polynomial $\frac{1}{R_0} = 2.5$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 3.25\right)$ τ=2 τ=30
$\left(\frac{C}{R_0} = 2.5\right)$ τ=2 τ=30
$\left(\frac{C}{R_0} = 2.75\right)$ τ=2 τ=30
$\left(\frac{C}{R_0} = 3\right)$ τ=2 τ=30
Fig. 29
0 1 2 3 4 5 6 7 8 9 10
β/τ
(Rotation away from pivot)
(Rotation toward pivot)


Eighth power polynomial $\frac{1}{R_0} = 3.0$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_0} = 3.75\right)$ τ=2 τ=30
$\left(\frac{C}{R_0} = 3\right)$ τ=2 τ=30
$\left(\frac{C}{R_0} = 3.5\right)$ τ=2 τ=30
$\left(\frac{C}{R_0} = 3.25\right)$ τ=2 τ=30
Fig. 30
0 1 2 3 4 5 6 7 8 9 10
β/τ
(Rotation away from pivot)
(Rotation toward pivot)

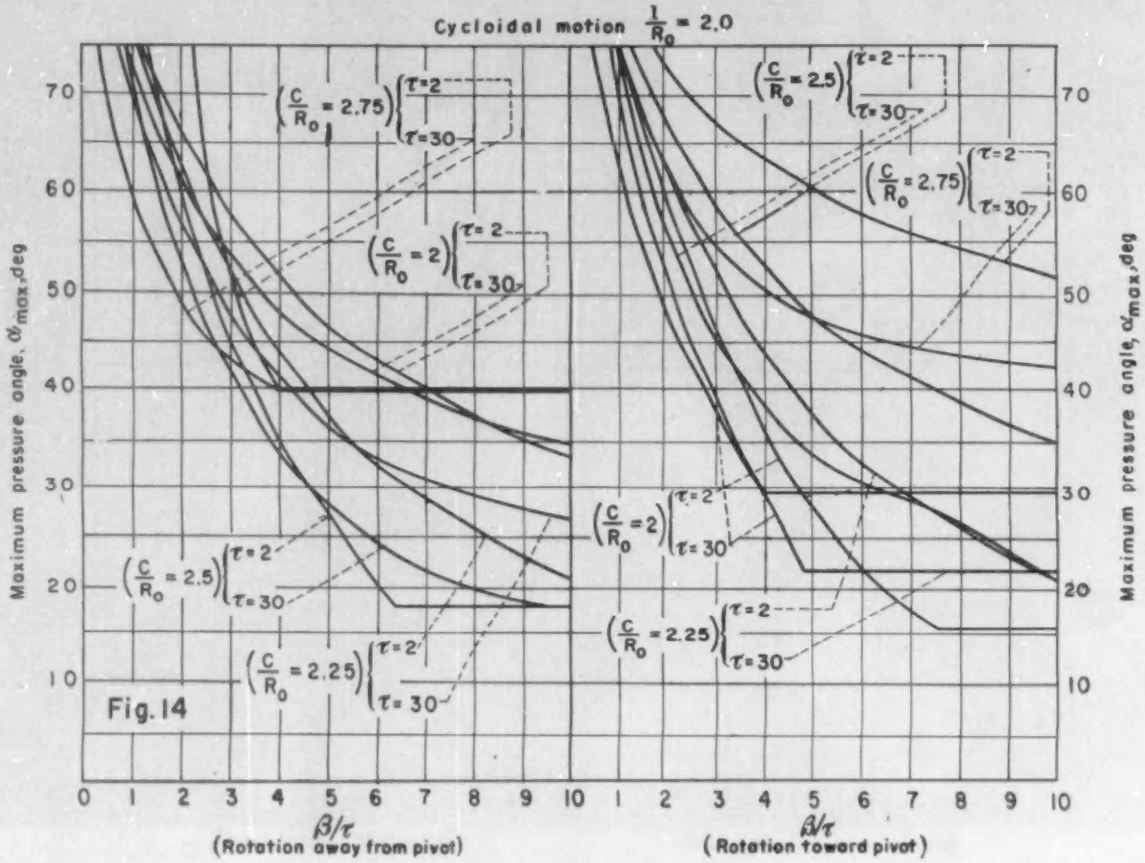


Fig. 14

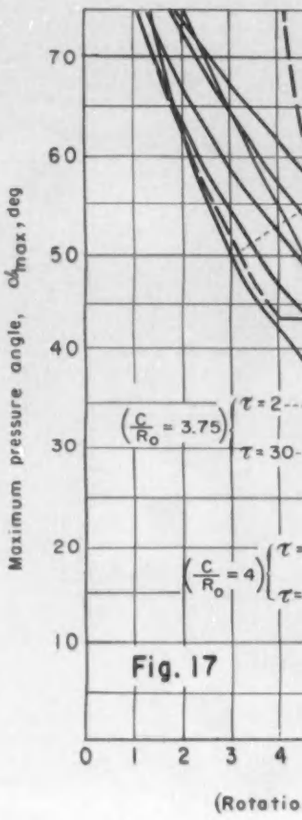


Fig. 17

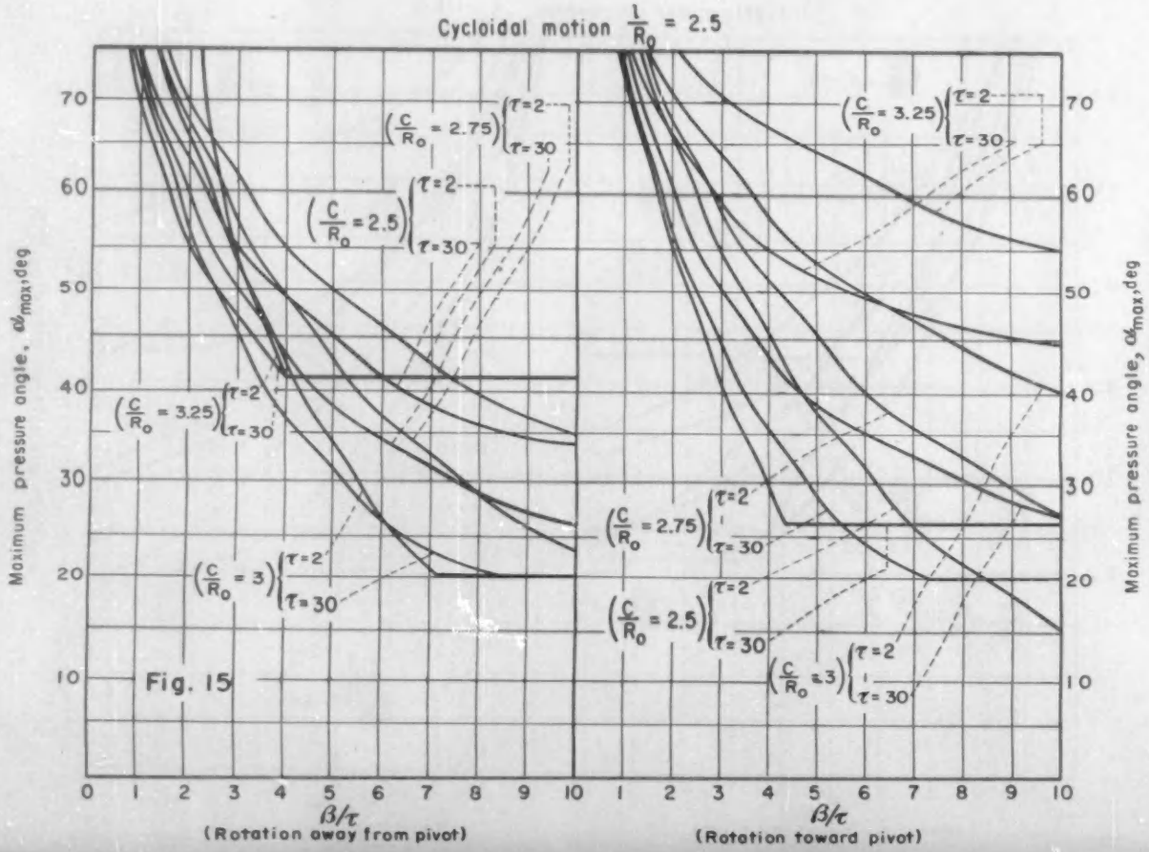


Fig. 15

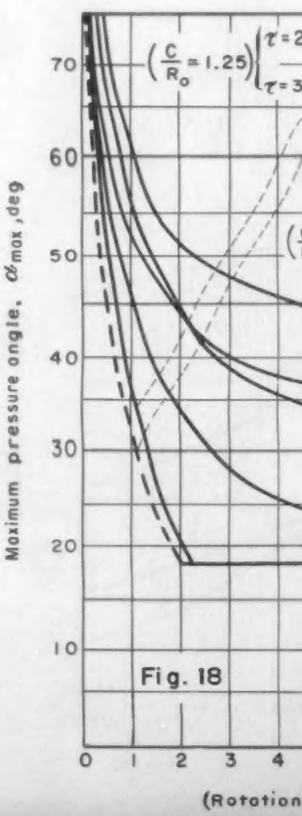
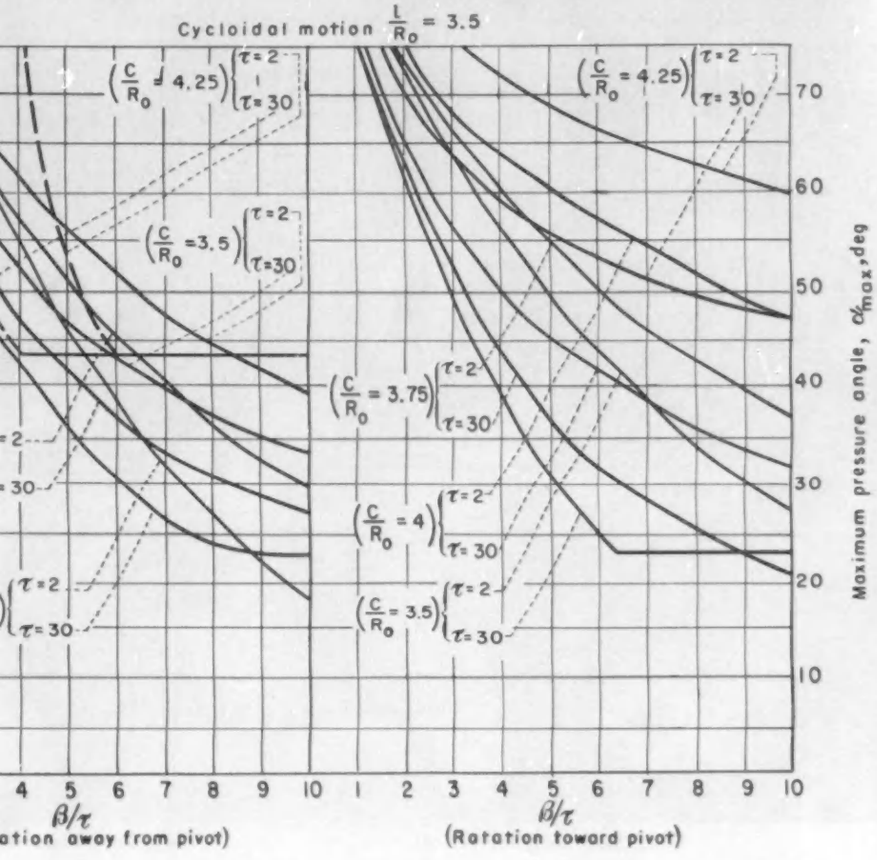
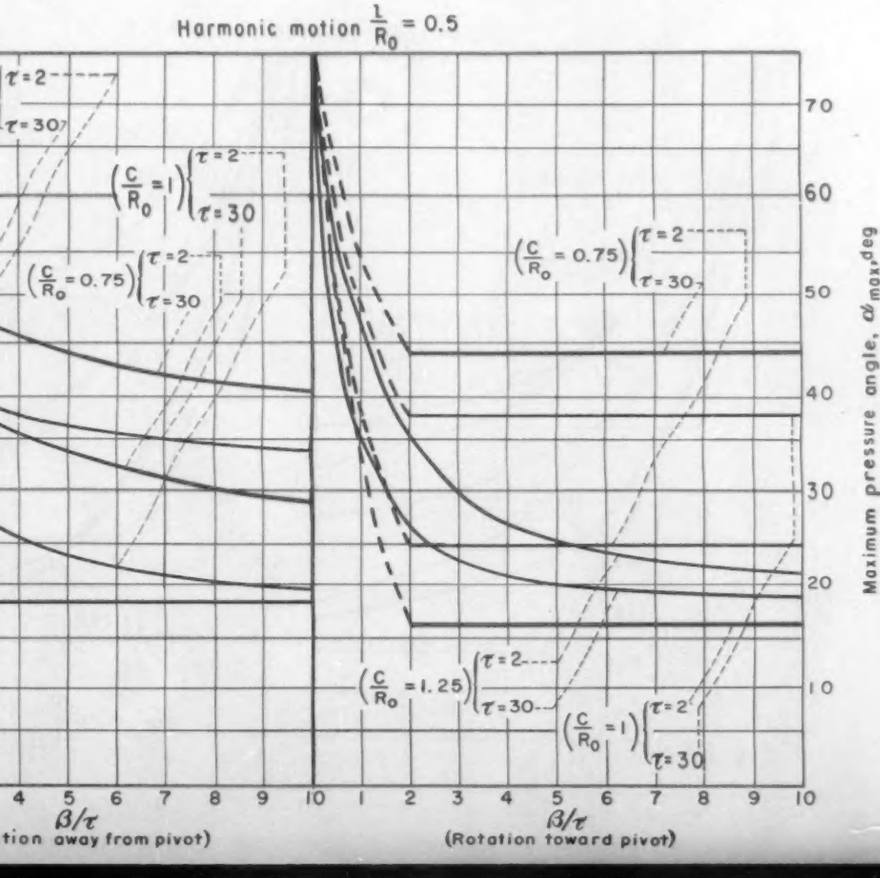
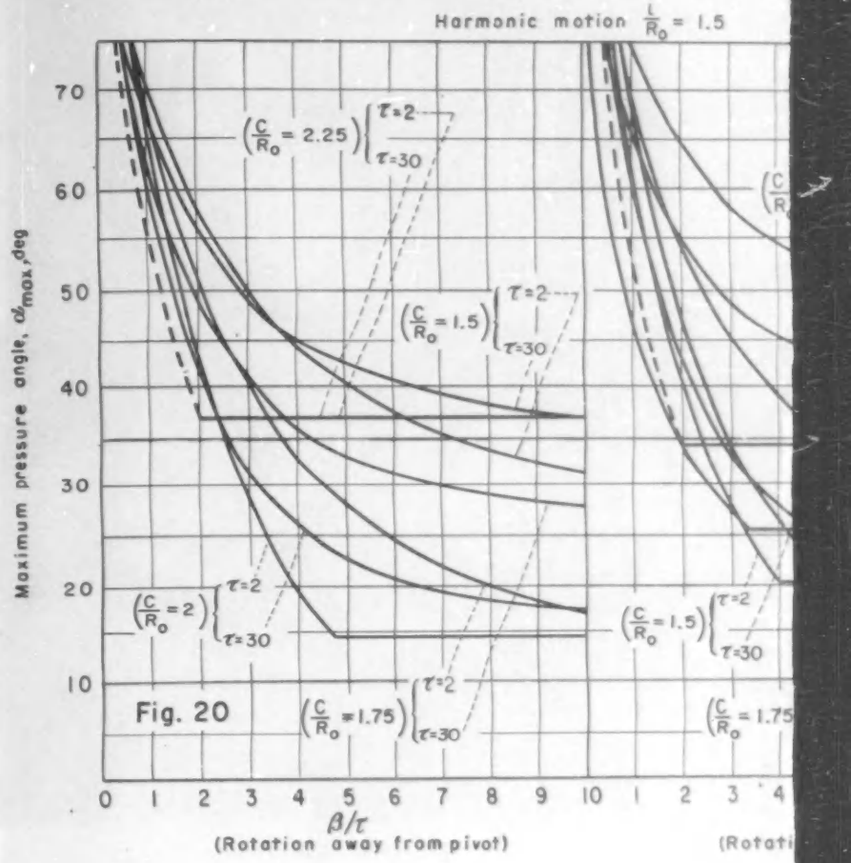
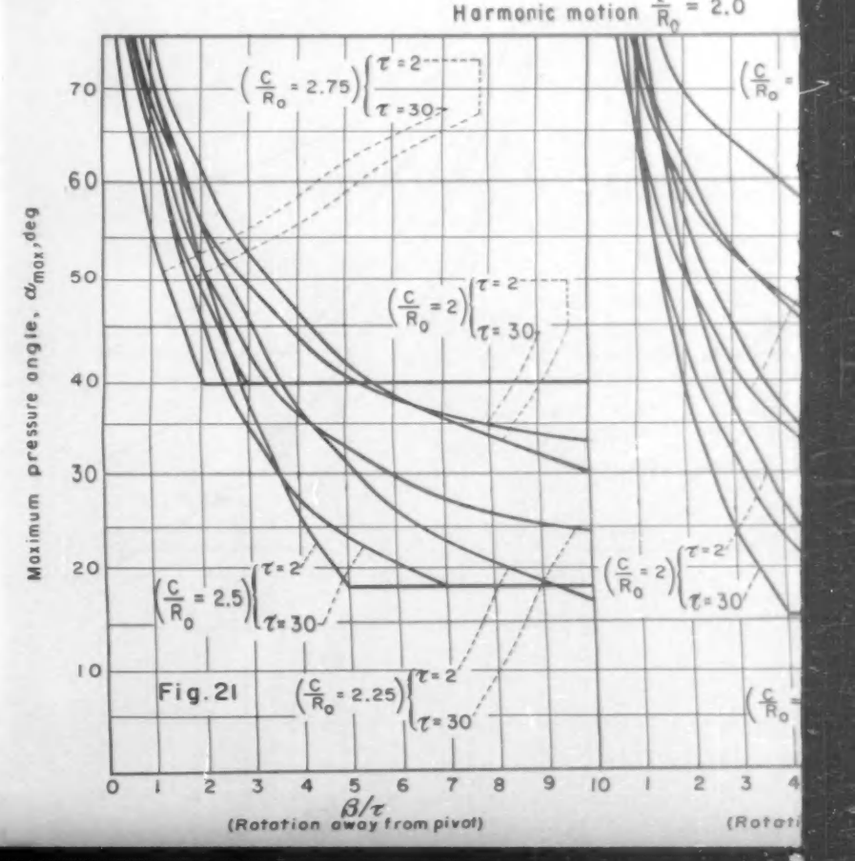


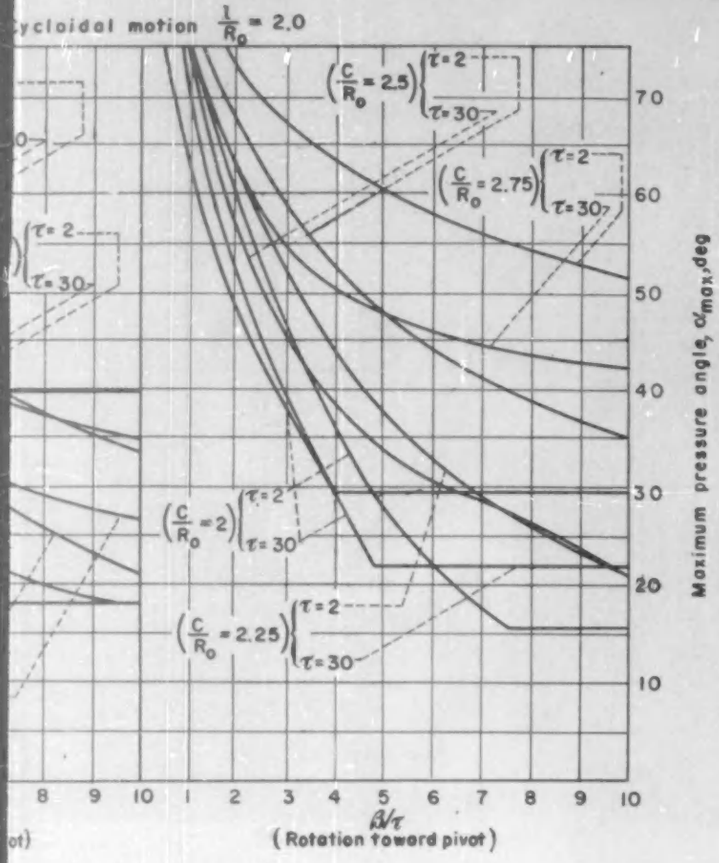
Fig. 18

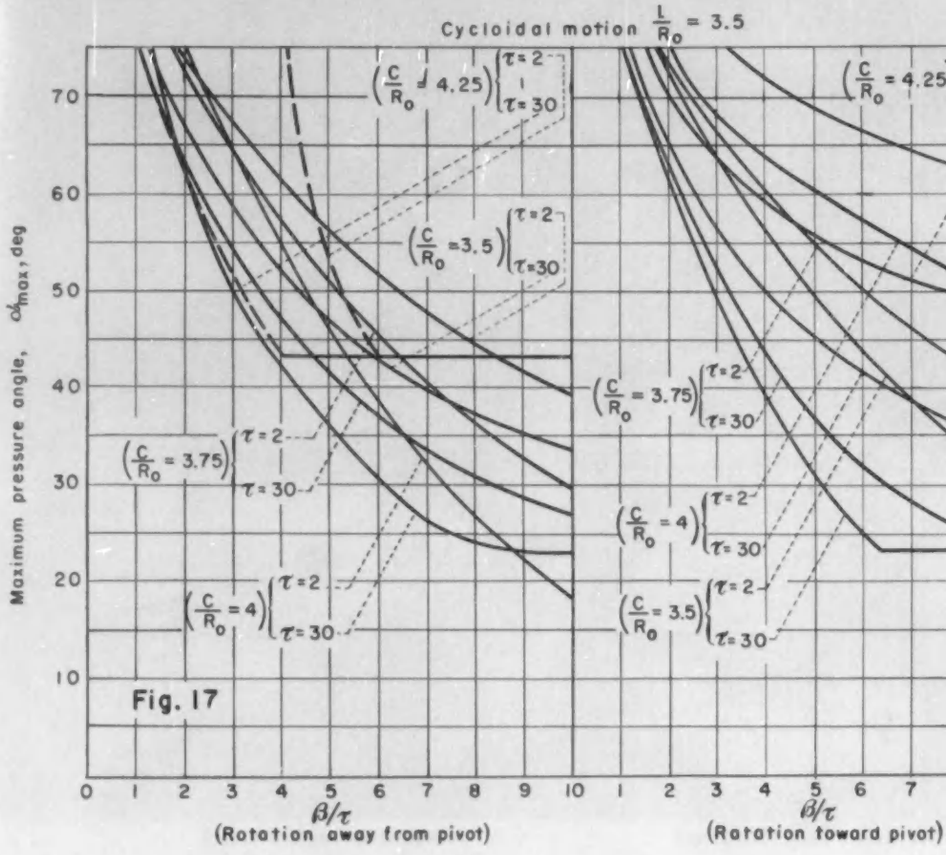

Cycloidal motion $\frac{L}{R_0} = 3.5$
$\left(\frac{C}{R_0} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
β/τ
(Rotation toward pivot)

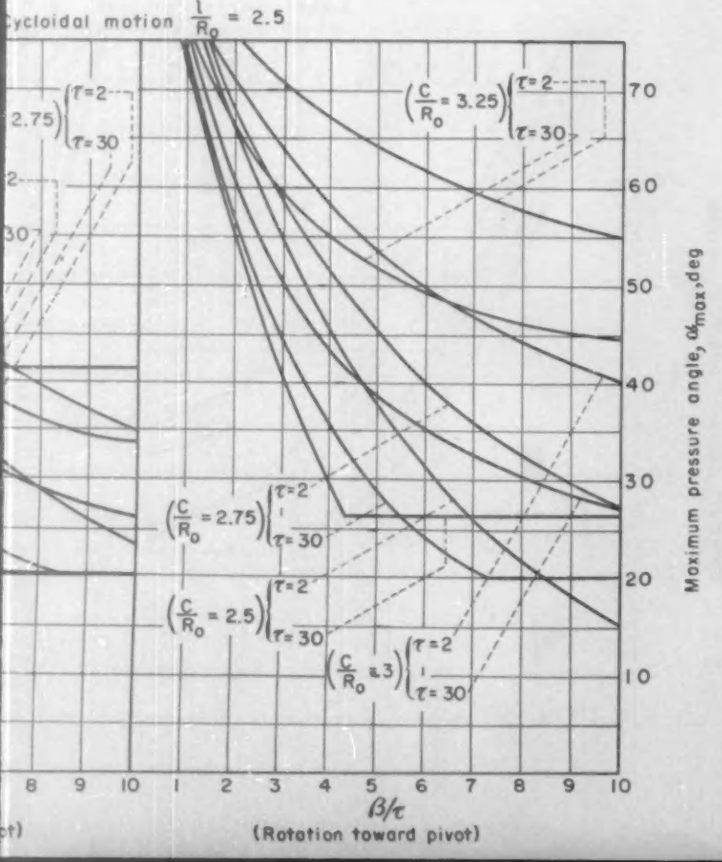

Harmonic motion $\frac{L}{R_0} = 0.5$
$\left(\frac{C}{R_0} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 0.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 0.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
β/τ
(Rotation toward pivot)

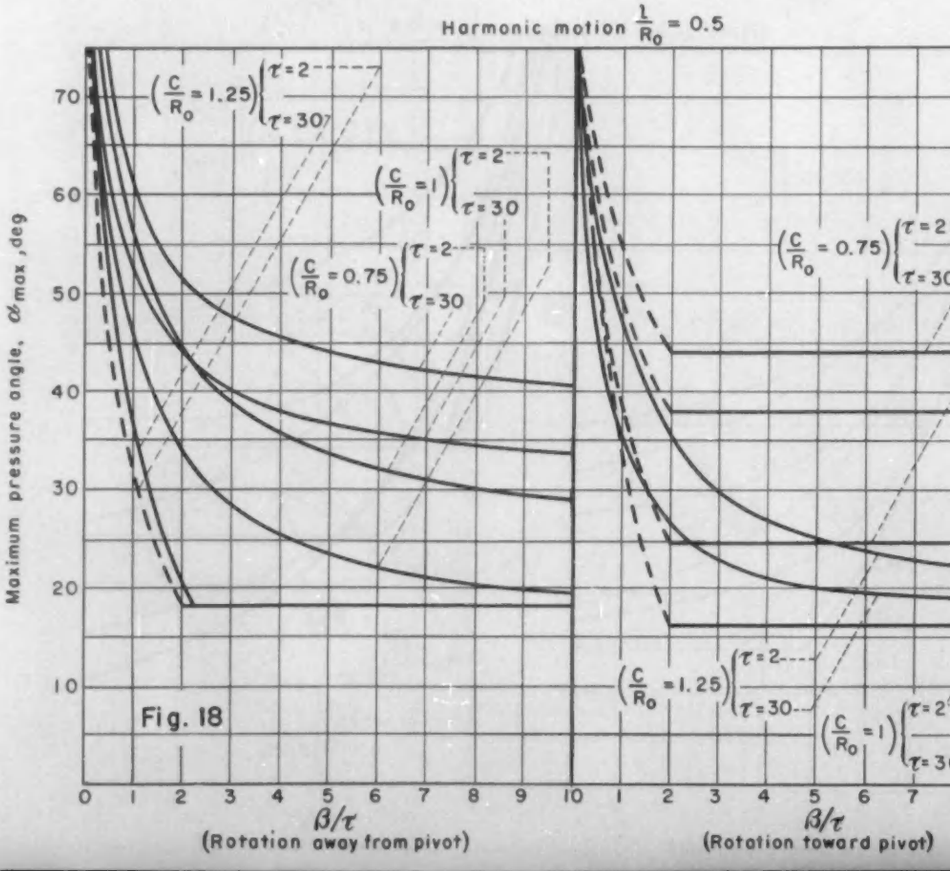

Harmonic motion $\frac{L}{R_0} = 1.5$
$\left(\frac{C}{R_0} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
Fig. 20
β/τ
(Rotation away from pivot)

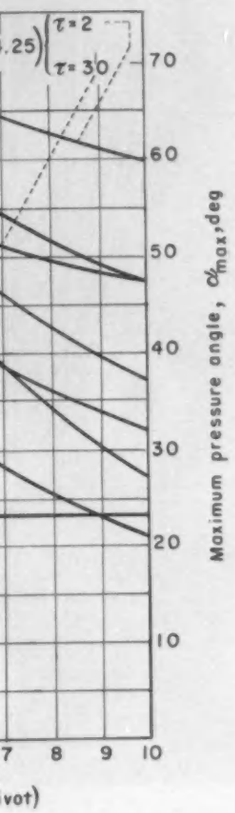

Harmonic motion $\frac{L}{R_0} = 2.0$
$\left(\frac{C}{R_0} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_0} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
Fig. 21
β/τ
(Rotation away from pivot)


Cycloidal motion $\frac{1}{R_0} = 2.0$
$\left(\frac{C}{R_0} = 2.5\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2.75\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2.25\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
Maximum pressure angle, α'_{max}, deg
β/τ
(Rotation toward pivot)


Cycloidal motion $\frac{1}{R_0} = 3.5$
$\left(\frac{C}{R_0} = 4.25\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 3.5\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 3.75\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 4\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
Maximum pressure angle, α'_{max}, deg
Fig. 17
β/τ
(Rotation away from pivot)
(Rotation toward pivot)


Cycloidal motion $\frac{1}{R_0} = 2.5$
$\left(\frac{C}{R_0} = 3.25\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2.75\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2.5\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 3\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
Maximum pressure angle, α'_{max}, deg
β/τ
(Rotation toward pivot)


Harmonic motion $\frac{1}{R_0} = 0.5$
$\left(\frac{C}{R_0} = 1.25\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 1\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 0.75\right)\left\{\begin{matrix}\tau=2 \\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 0.75\right)$
$\left(\frac{C}{R_0} = 1.25\right)$
Maximum pressure angle, α'_{max}, deg
Fig. 18
β/τ
(Rotation away from pivot)
(Rotation toward pivot)


Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)

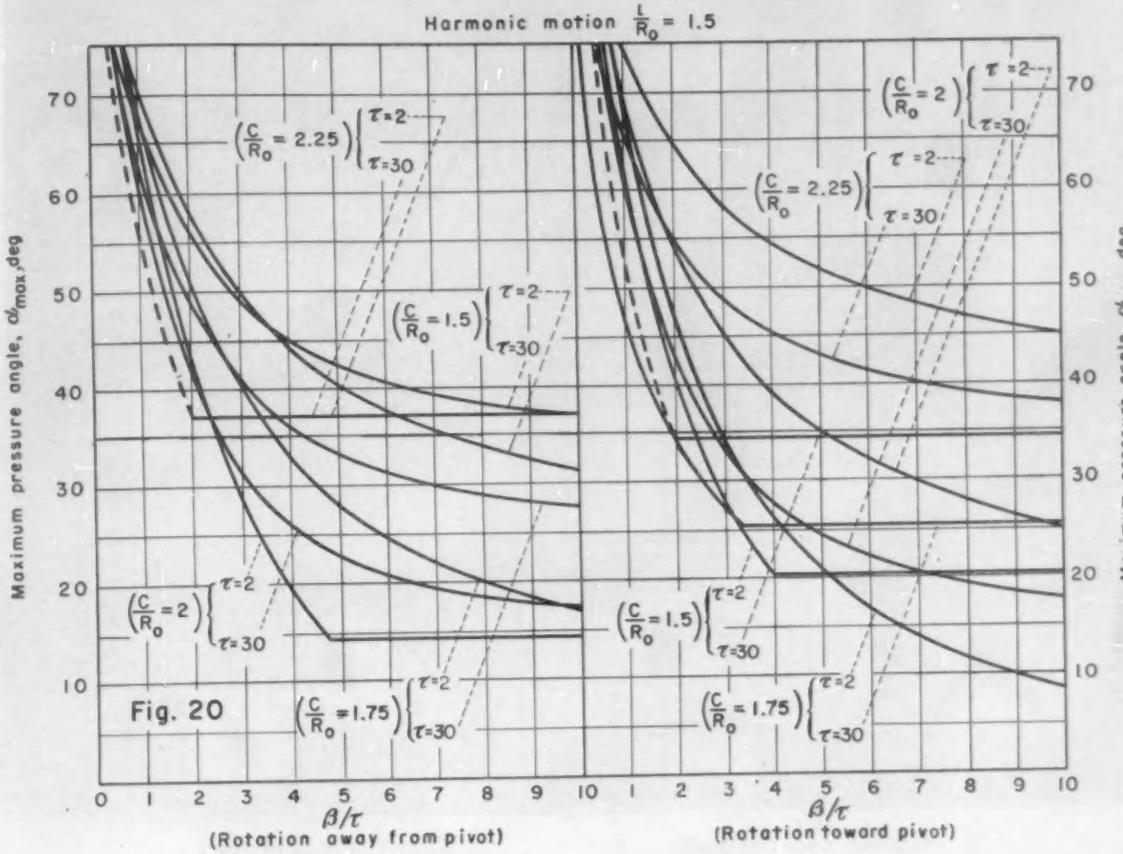
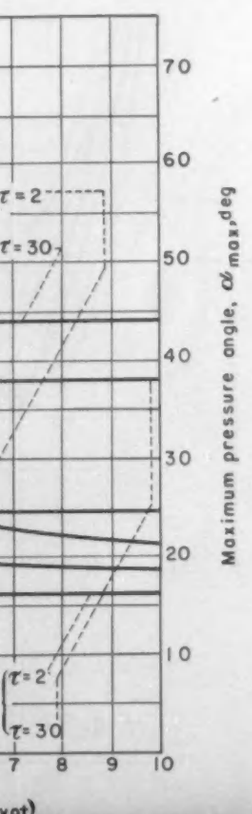

Harmonic motion $\frac{L}{R_0} = 1.5$
$\left(\frac{C}{R_0} = 2.25\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 1.5\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 1.75\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward pivot)

Fig. 20


Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)

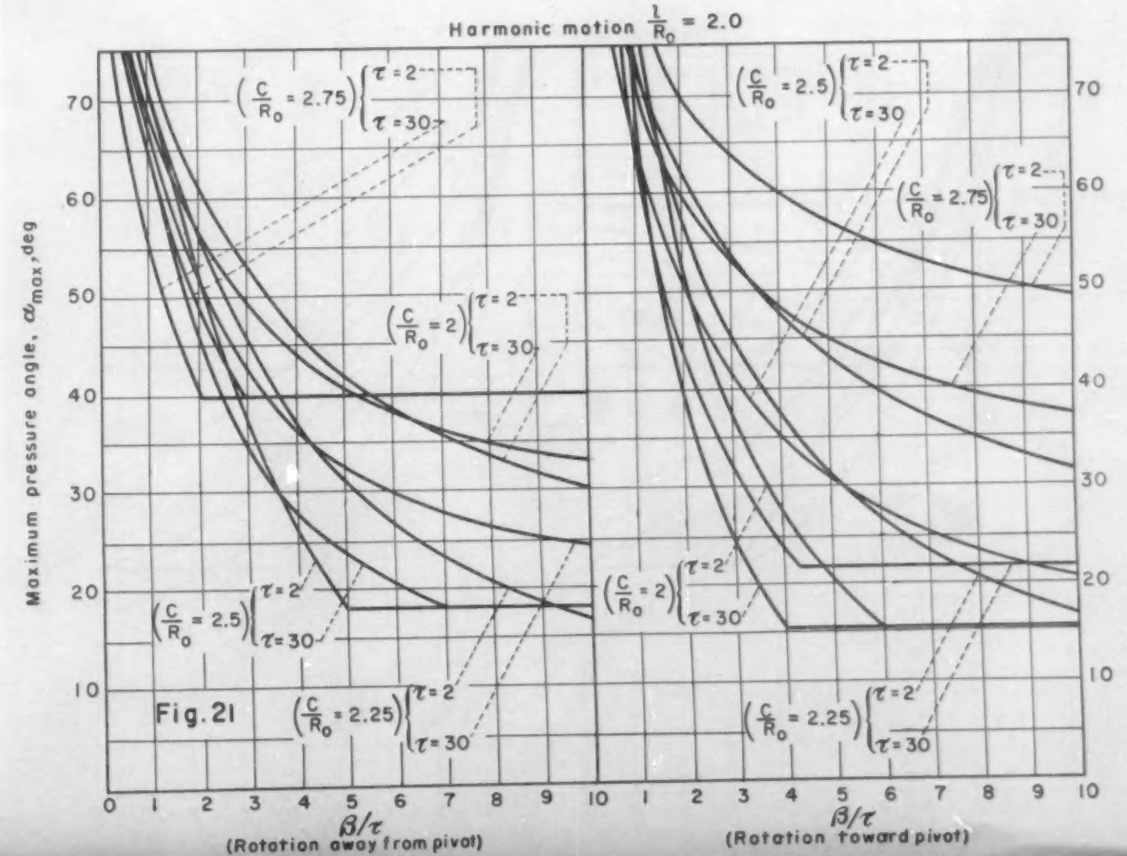
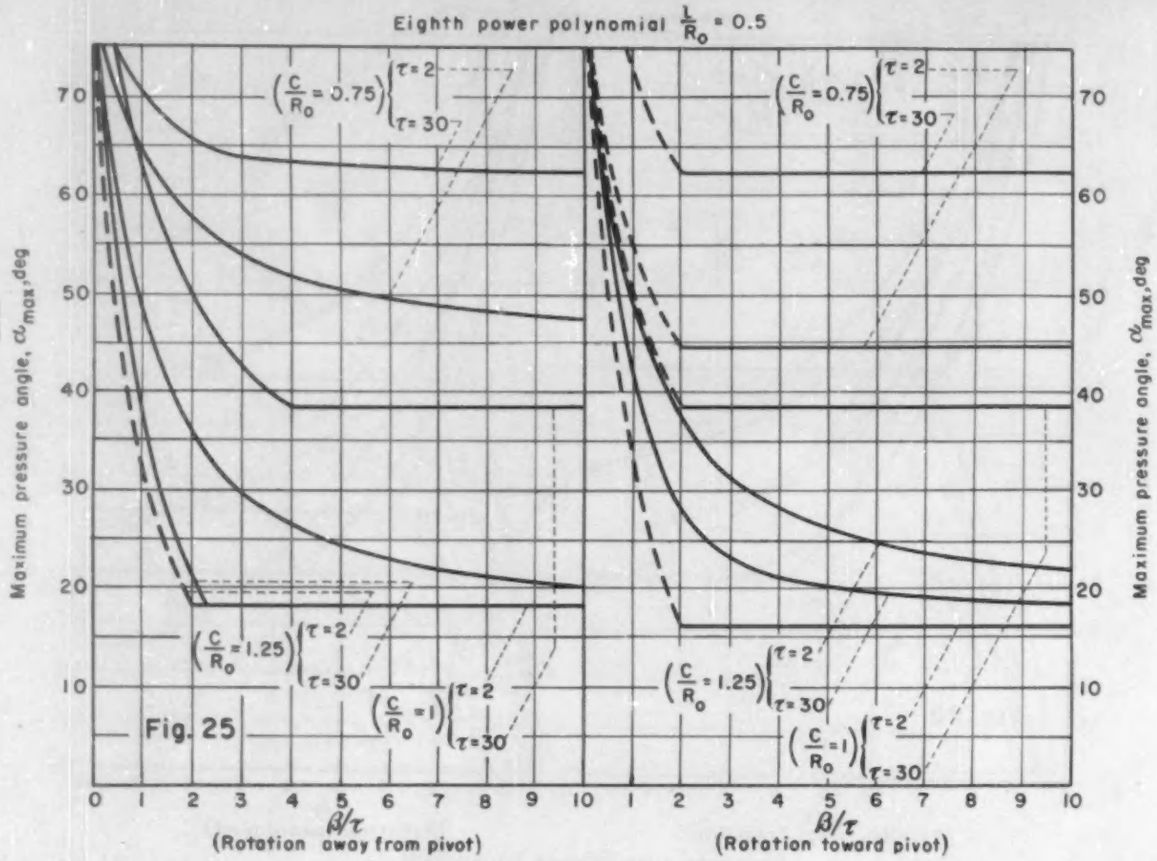
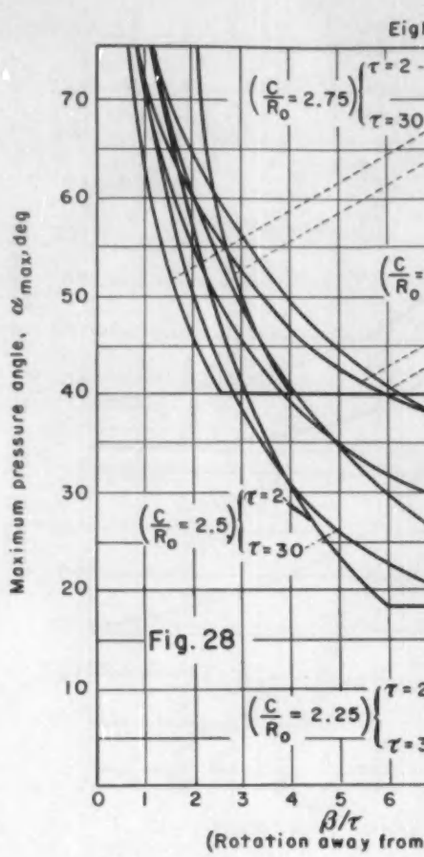
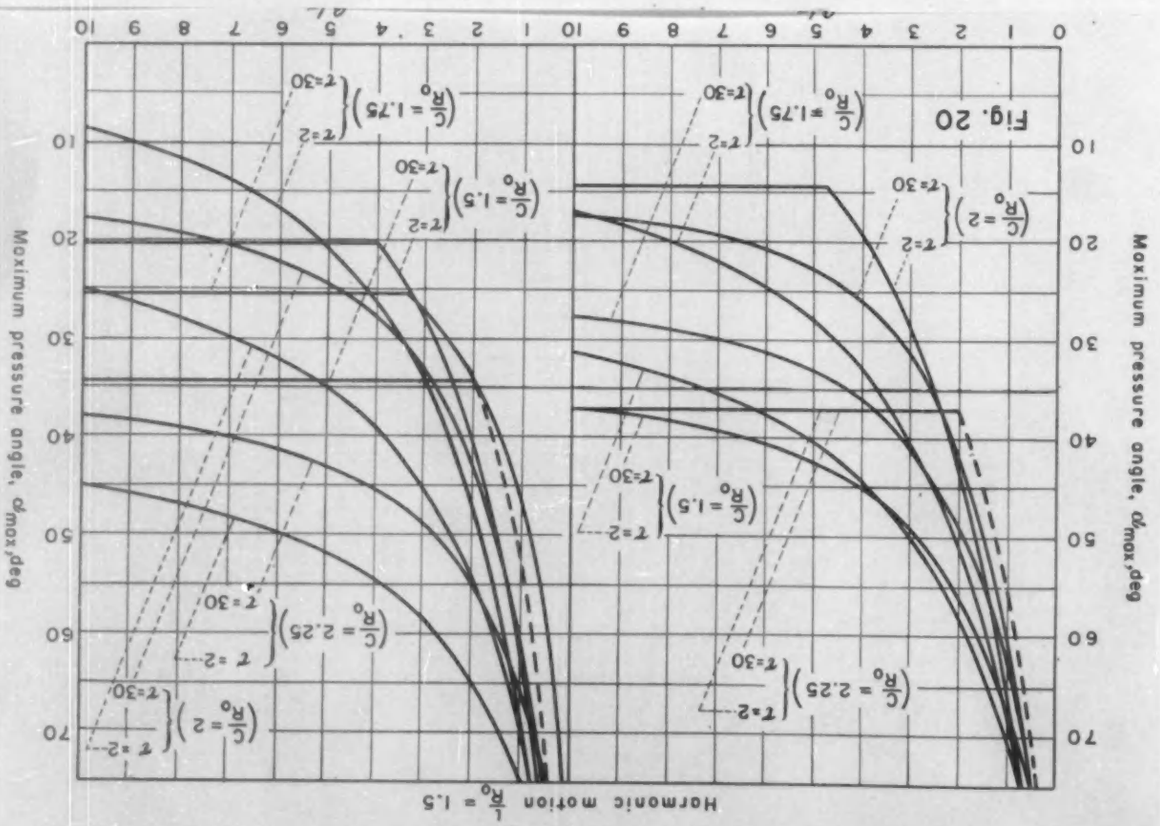
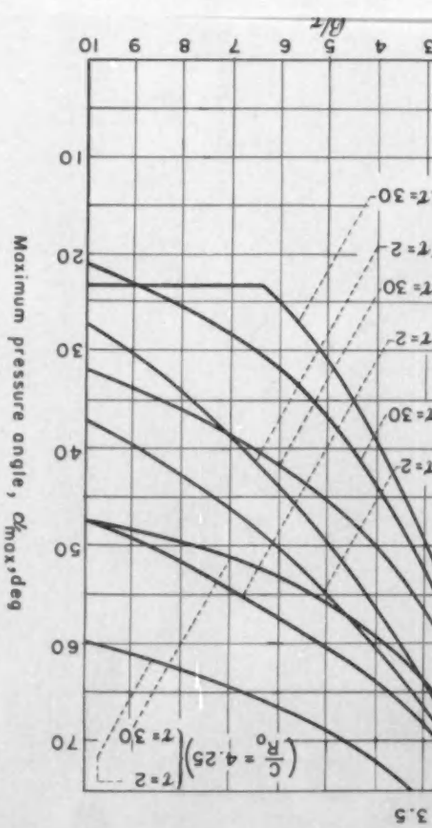

Harmonic motion $\frac{L}{R_0} = 2.0$
$\left(\frac{C}{R_0} = 2.75\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2.5\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
$\left(\frac{C}{R_0} = 2.25\right)\left\{\begin{matrix}\tau=2\\ \tau=30\end{matrix}\right.$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward pivot)

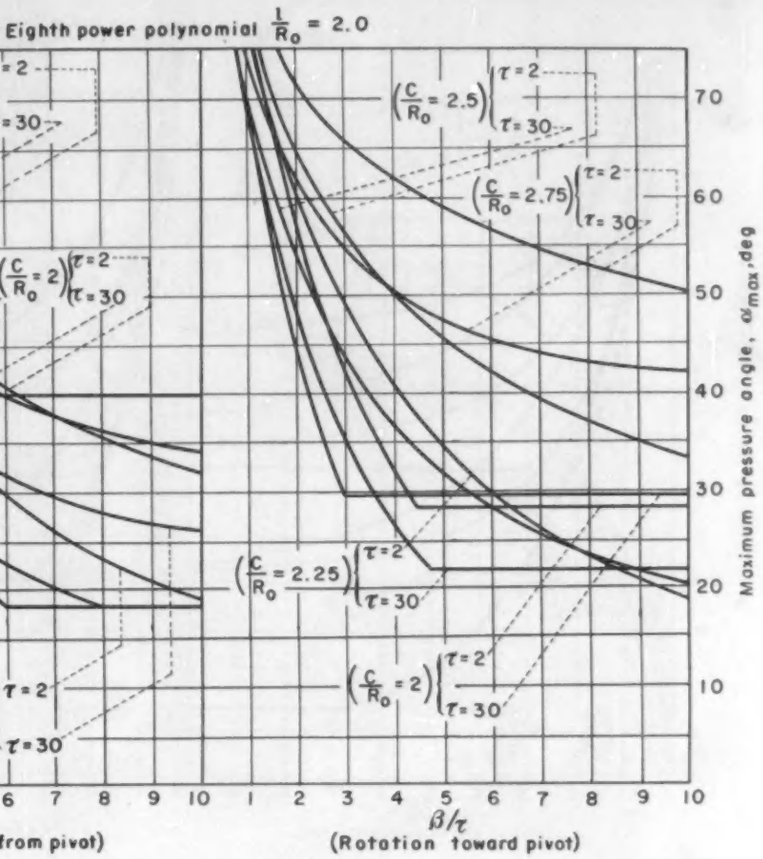
Fig. 21


Eighth power polynomial $\frac{L}{R_o} = 0.5$
Maximum pressure angle, α_{max}, deg
$\frac{\beta}{\tau}$
(Rotation away from pivot)
(Rotation toward pivot)
$\left(\frac{C}{R_o}=0.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 25


Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o}=2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2.25\right)$
Fig. 28


Harmonic motion $\frac{L}{R_o} = 1.5$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o}=2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o}=1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Fig. 20


Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o}=4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$


Eighth power polynomial $\frac{1}{R_o} = 2.0$
$\left(\frac{C}{R_o} = 2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α'_{max}, deg
β/τ
(Rotation toward pivot)
from pivot)

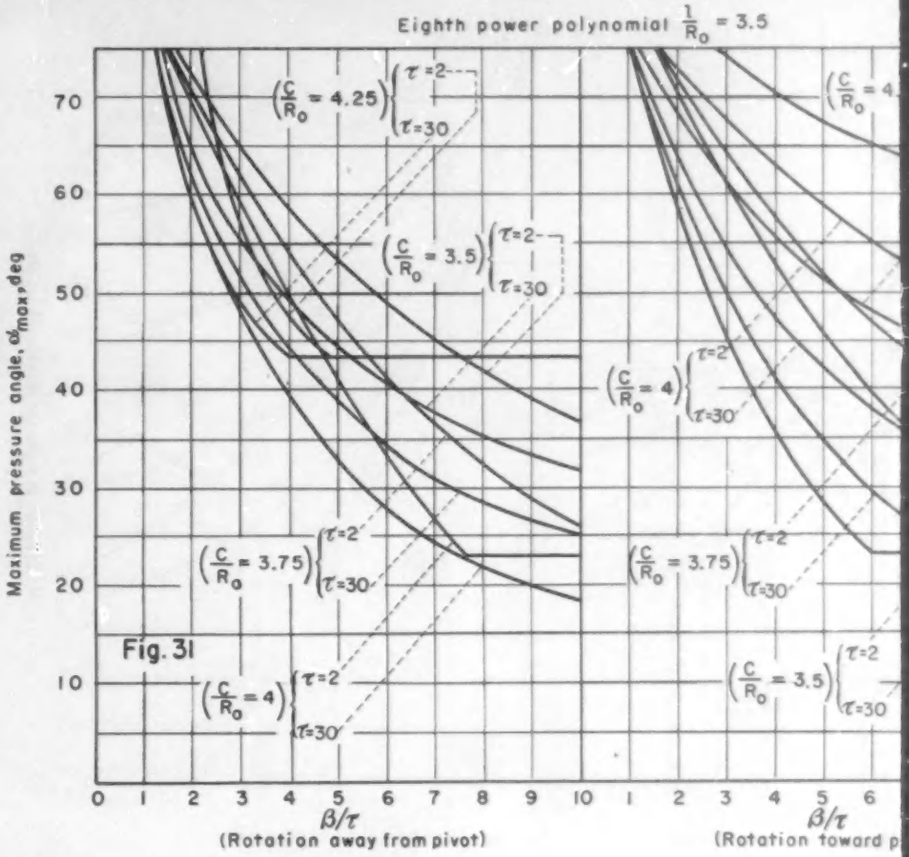

Eighth power polynomial $\frac{1}{R_o} = 3.5$
$\left(\frac{C}{R_o} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α'_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward p

Fig. 31

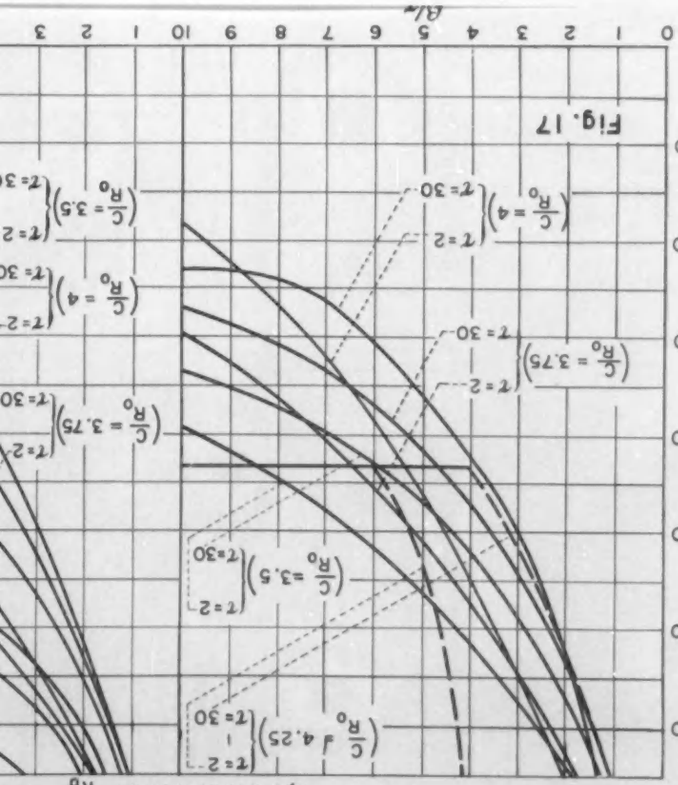
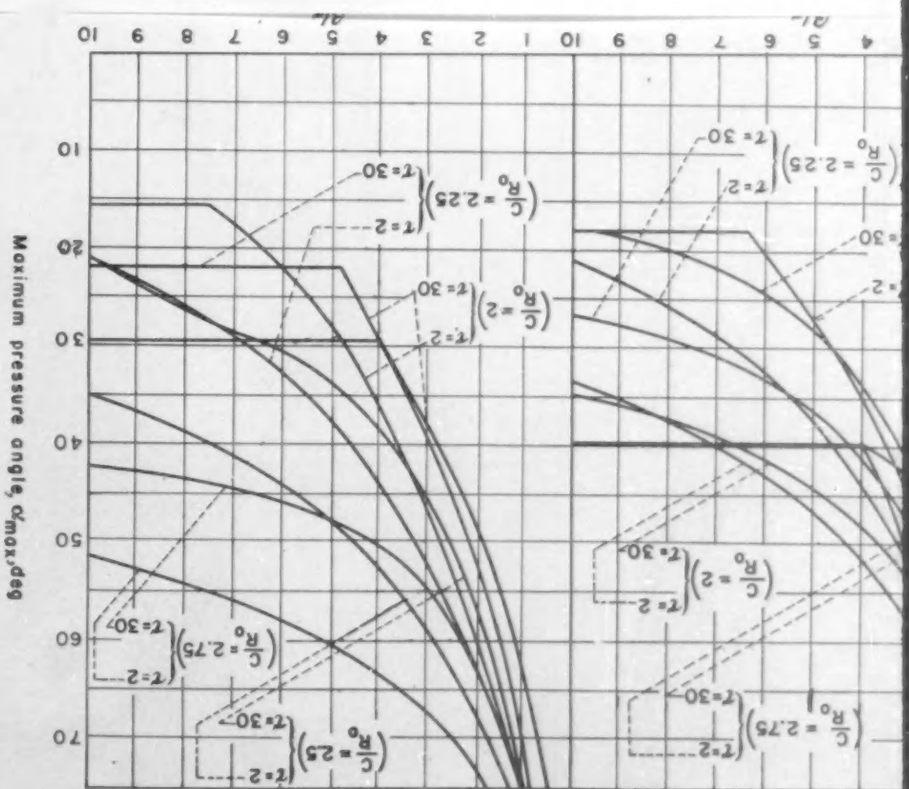
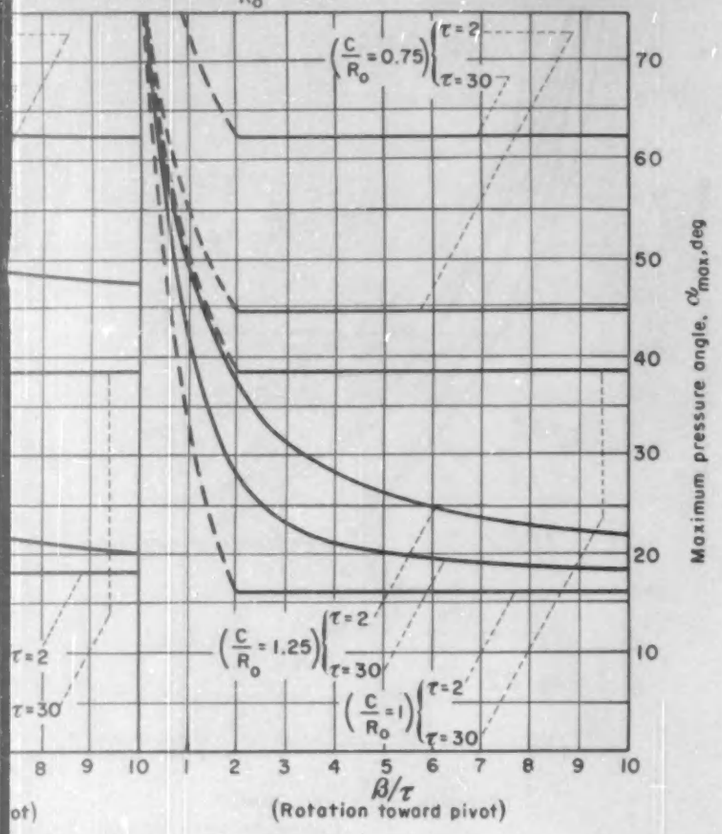
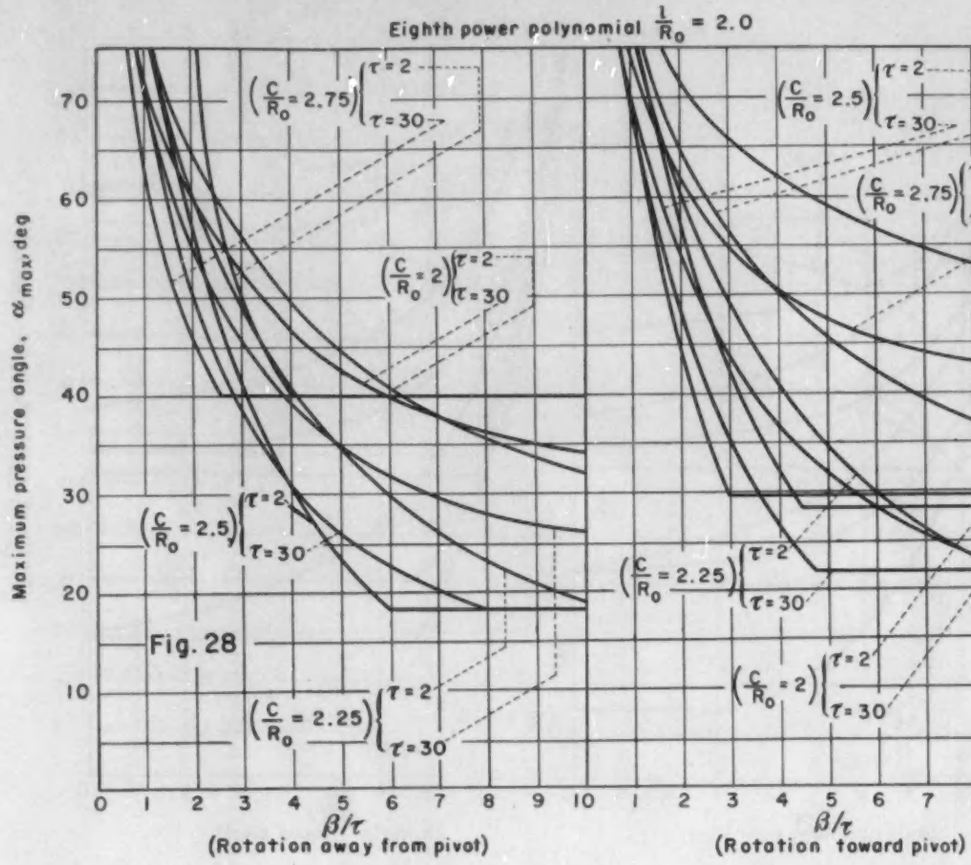
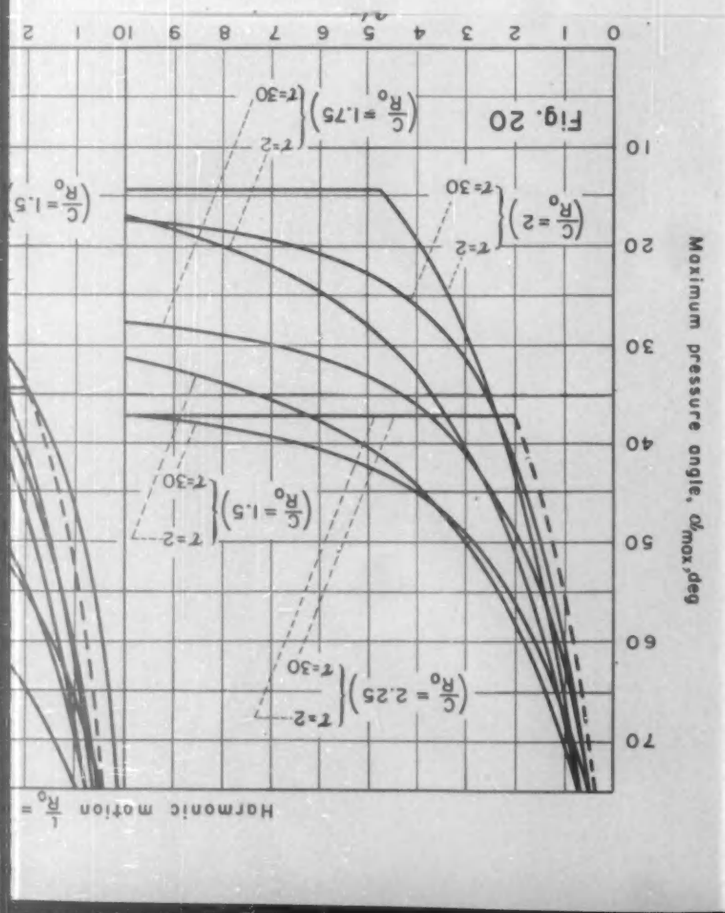

Cycloidal motion $\frac{1}{R_o} = 3.5$
$\left(\frac{C}{R_o} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α'_{max}, deg

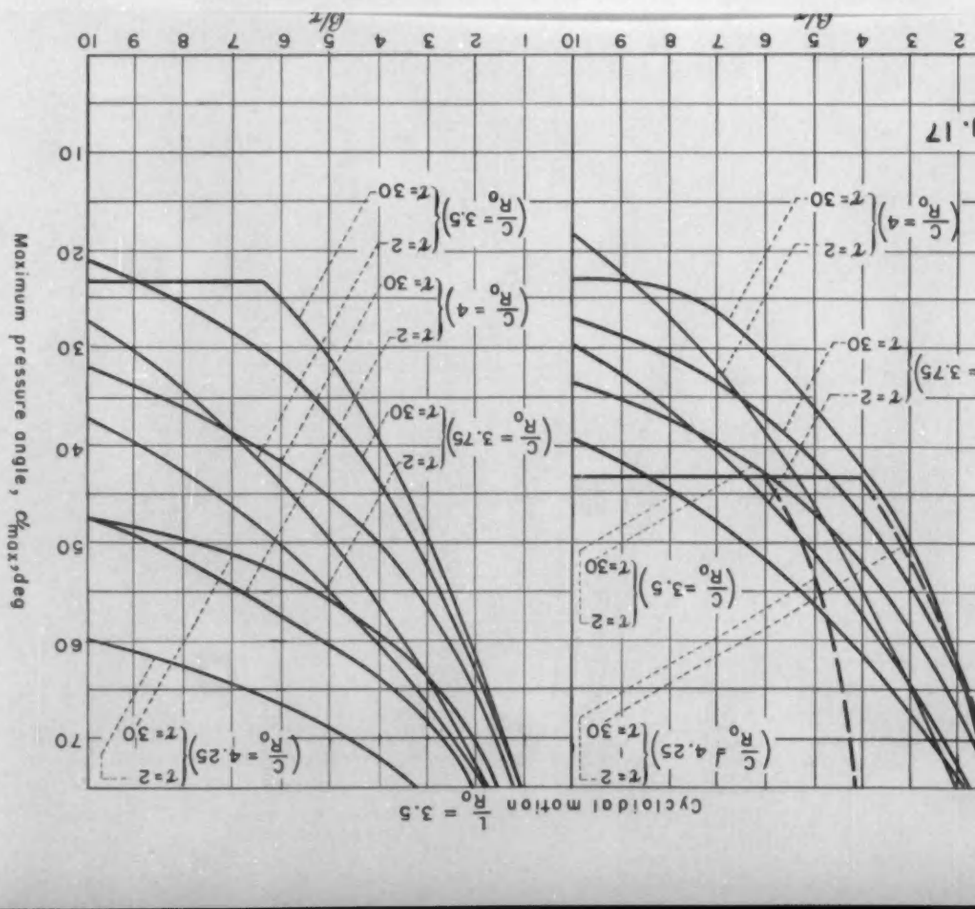
Fig. 17


Cycloidal motion $\frac{1}{R_o} = 2.0$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α'_{max}, deg


power polynomial $\frac{1}{R_o} = 0.5$
$\left(\frac{C}{R_o} = 0.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation toward pivot)


Eighth power polynomial $\frac{1}{R_o} = 2.0$
$\left(\frac{C}{R_o} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
Fig. 28
β/τ
(Rotation away from pivot)
$\left(\frac{C}{R_o} = 2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
β/τ
(Rotation toward pivot)


Harmonic motion $\frac{1}{R_o}$ =
$\left(\frac{C}{R_o} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
Fig. 20
$\left(\frac{C}{R_o} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$


Cycloidal motion $\frac{1}{R_o} = 3.5$
$\left(\frac{C}{R_o} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg

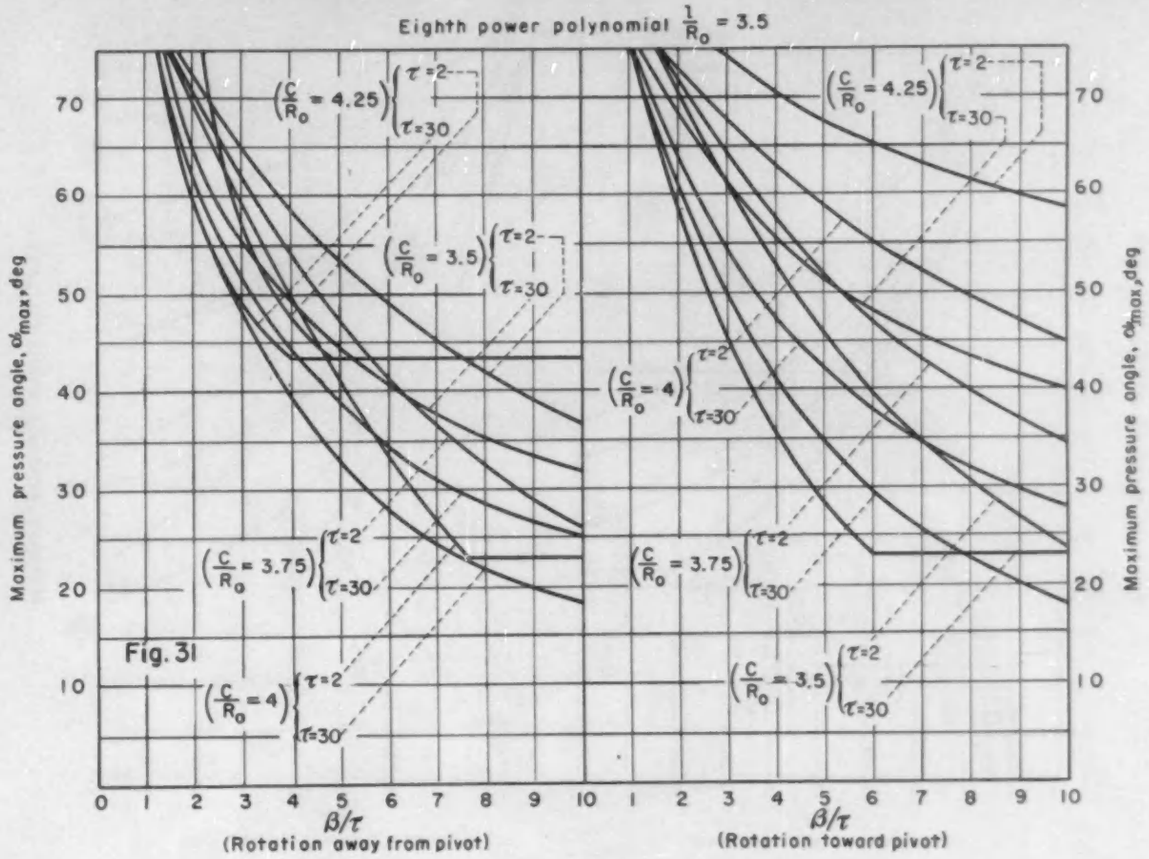

Eighth power polynomial $\frac{1}{R_o} = 3.5$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward pivot)
$\left(\frac{C}{R_o} = 4.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 4\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$

Fig. 31

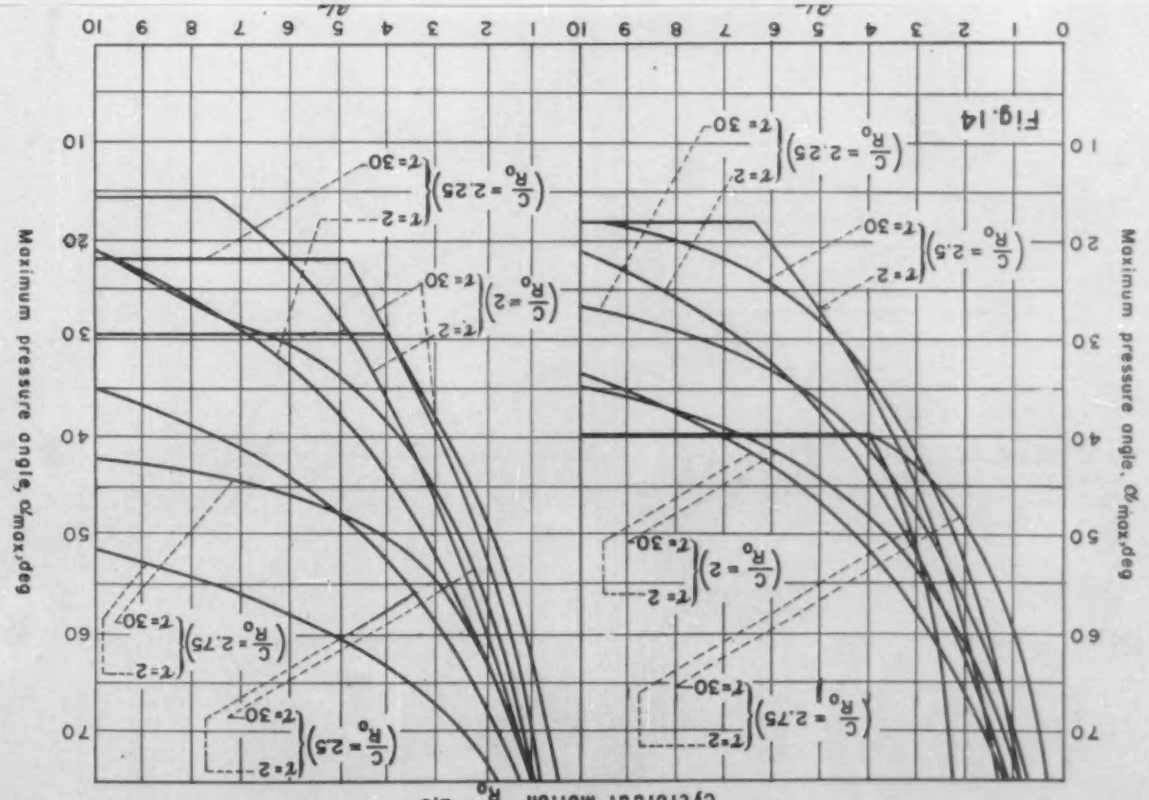
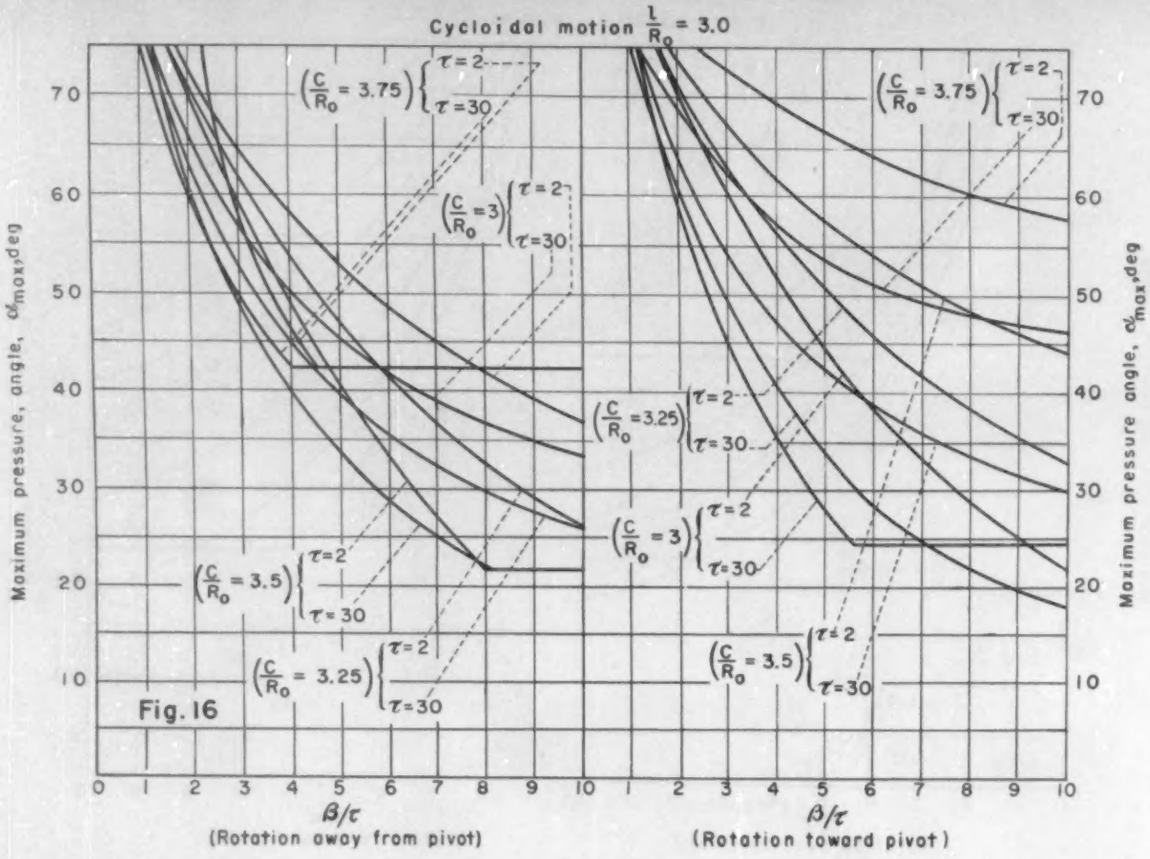
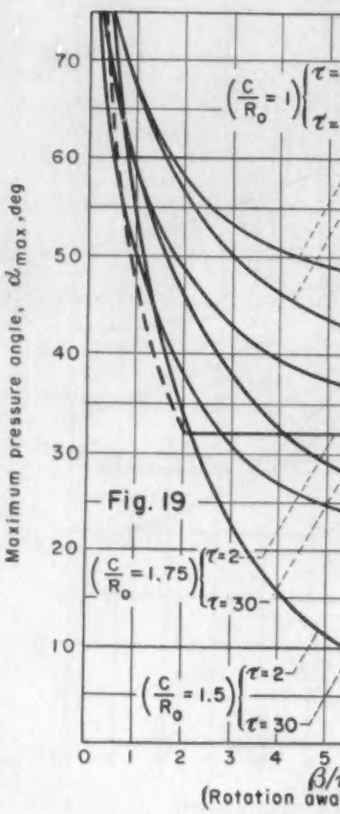
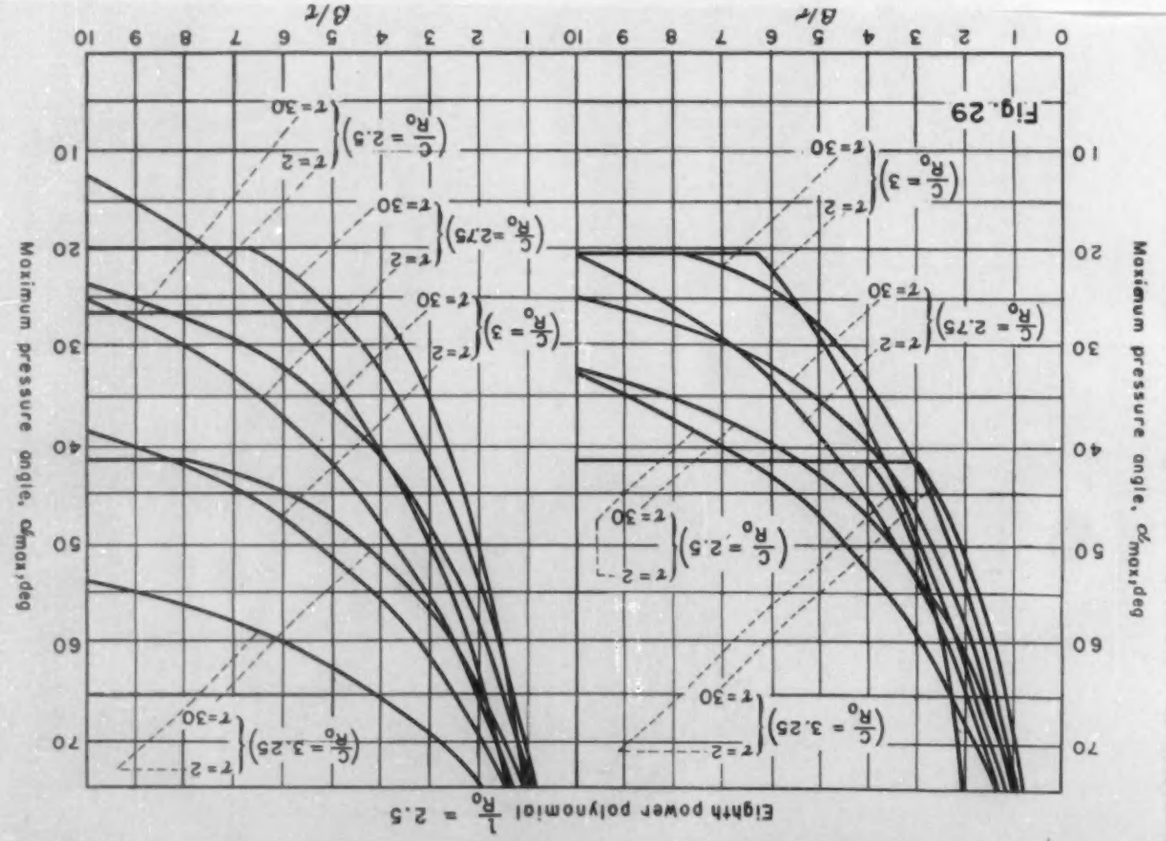
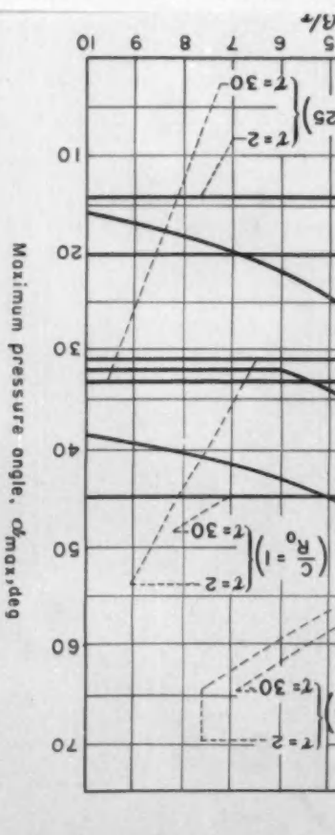

Cycloidal motion $\frac{1}{R_o} = 2.0$
Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$

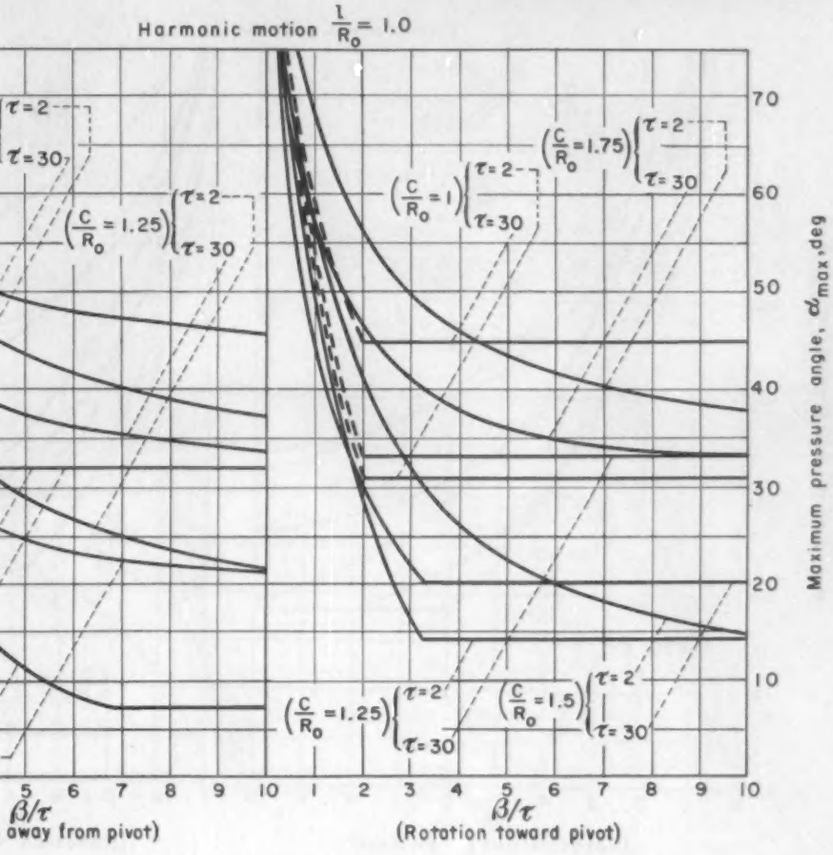
Fig. 14


Cycloidal motion $\frac{l}{R_o} = 3.0$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward pivot)
$\left(\frac{C}{R_o} = 3.75\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 3\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 3.5\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 3.25\right)\{\tau=2, \tau=30$
Fig. 16


Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o} = 1\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 1.75\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 1.5\right)\{\tau=2, \tau=30$
Fig. 19


Eighth power polynomial $\frac{l}{R_o} = 2.5$
Maximum pressure angle, α_{max}, deg
β/τ
$\left(\frac{C}{R_o} = 3.25\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 3\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 2.75\right)\{\tau=2, \tau=30$
$\left(\frac{C}{R_o} = 2.5\right)\{\tau=2, \tau=30$
Fig. 29


Maximum pressure angle, α_{max}, deg
$\left(\frac{C}{R_o} = 1\right)\{\tau=2, \tau=30$



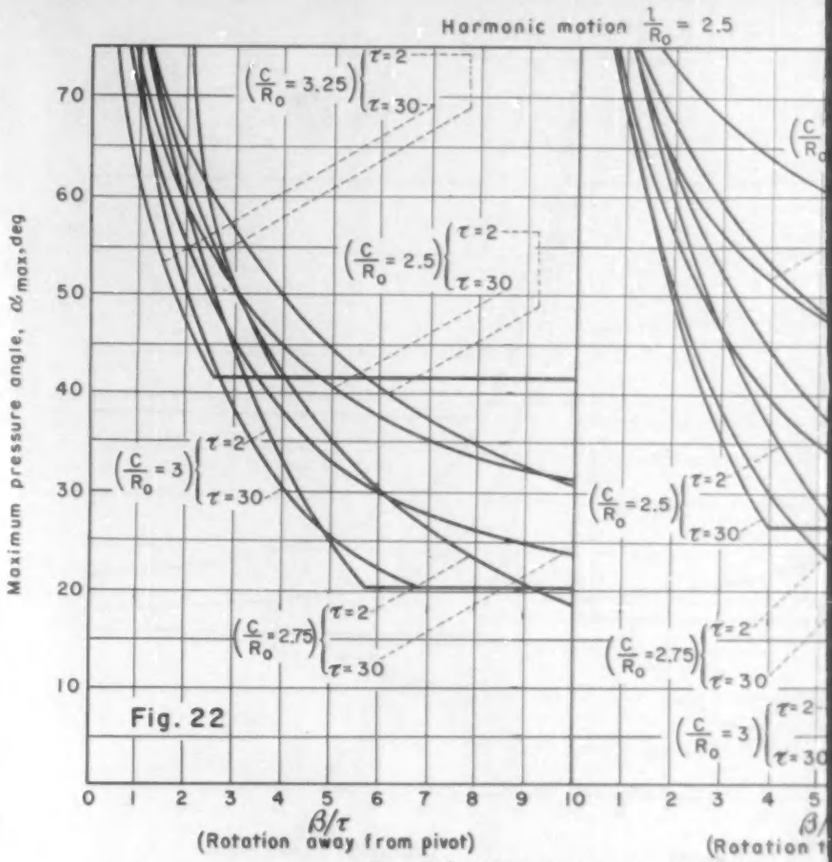


Fig. 22

Copyright 1955 Product Engineering

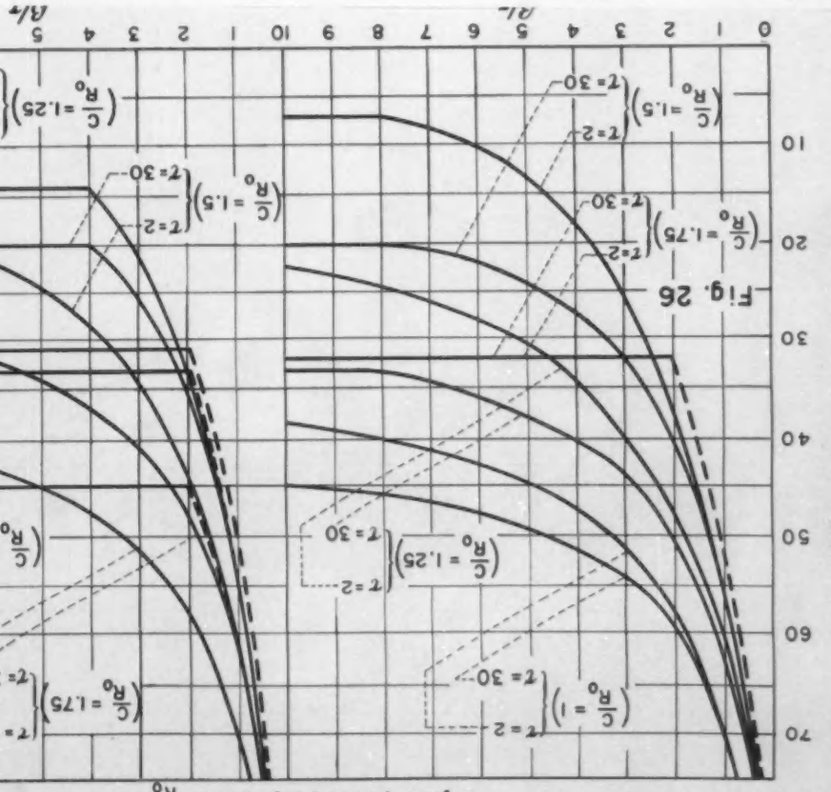
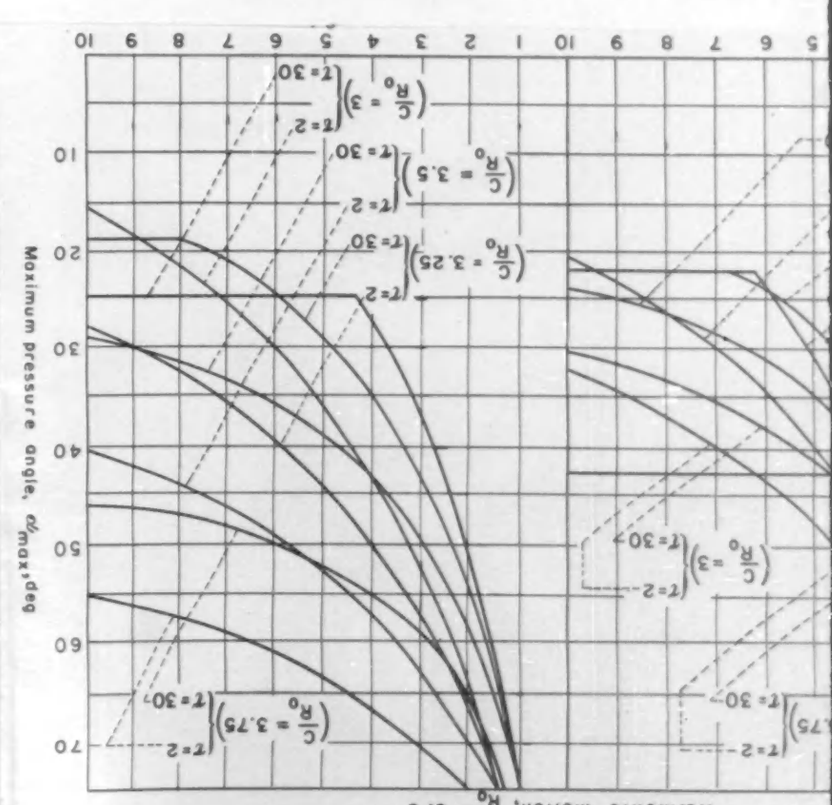
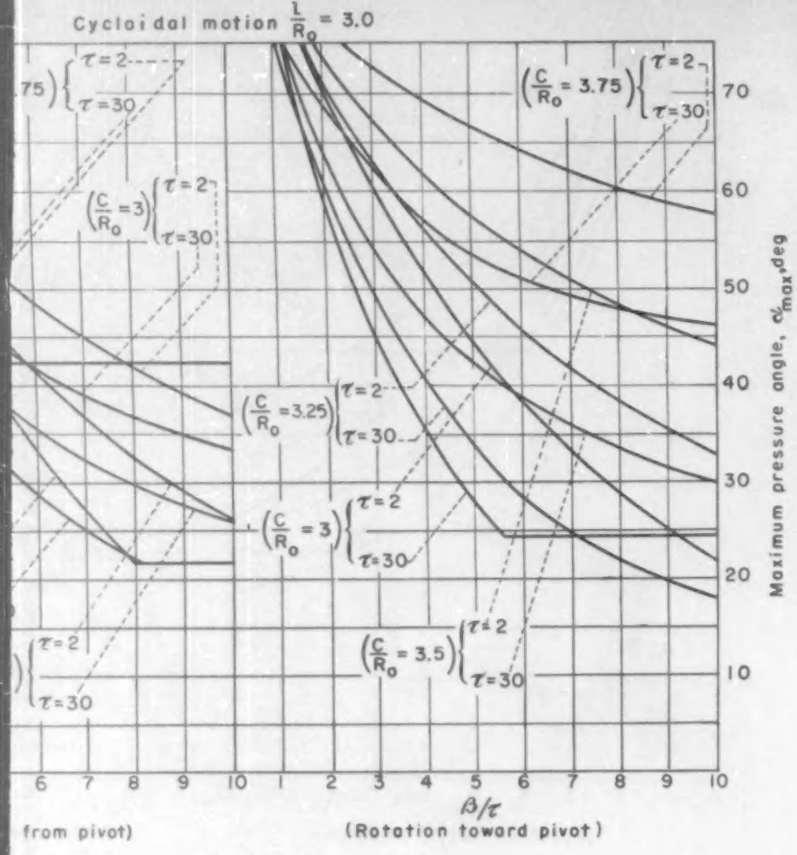


Fig. 26




Cycloidal motion $\frac{l}{R_o} = 3.0$
$\left(\frac{C}{R_o} = 3.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation toward pivot)
from pivot)

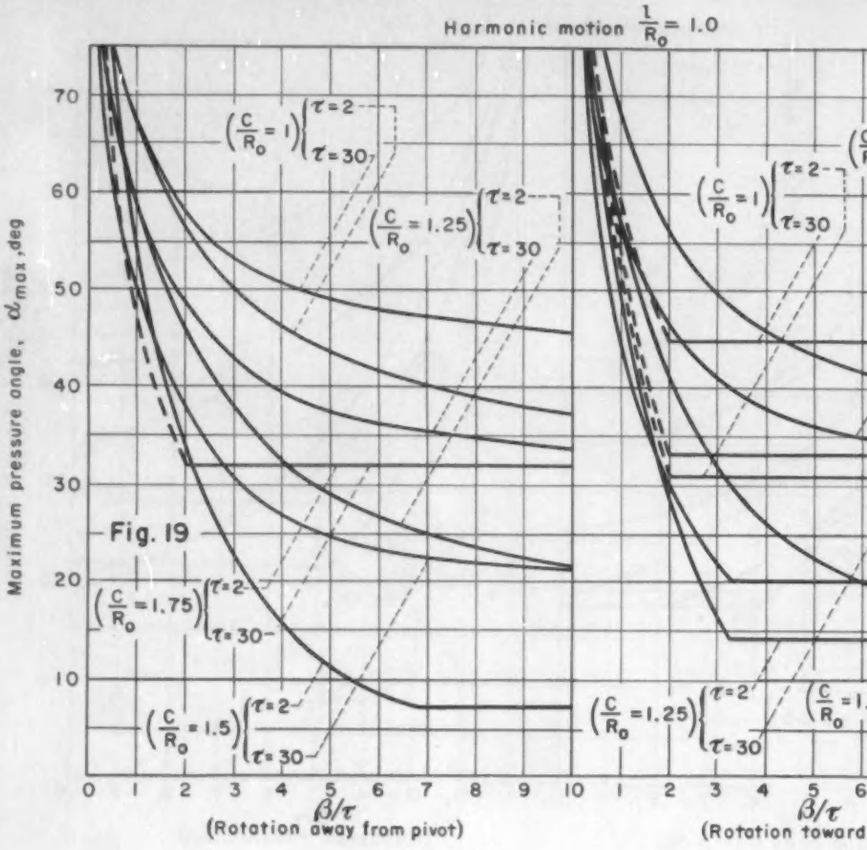

Harmonic motion $\frac{l}{R_o} = 1.0$
$\left(\frac{C}{R_o} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward

Fig. 19

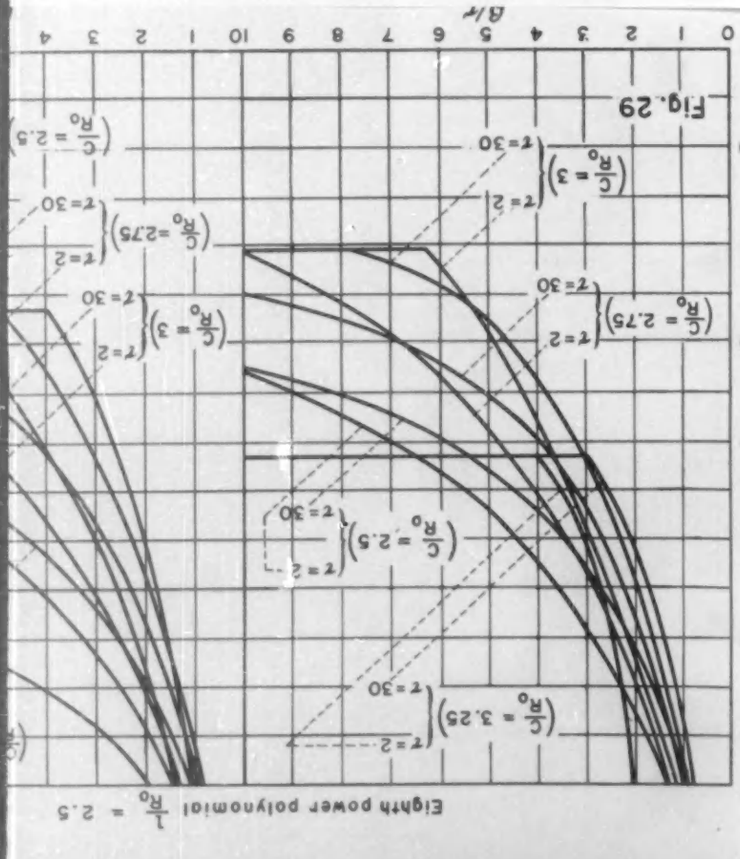
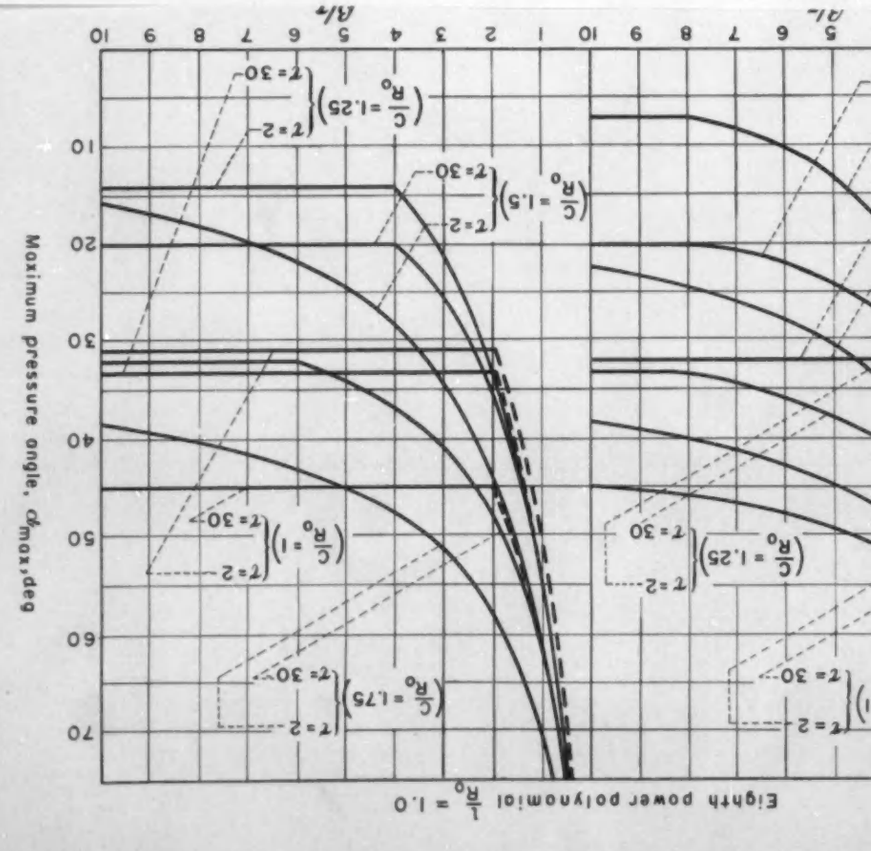
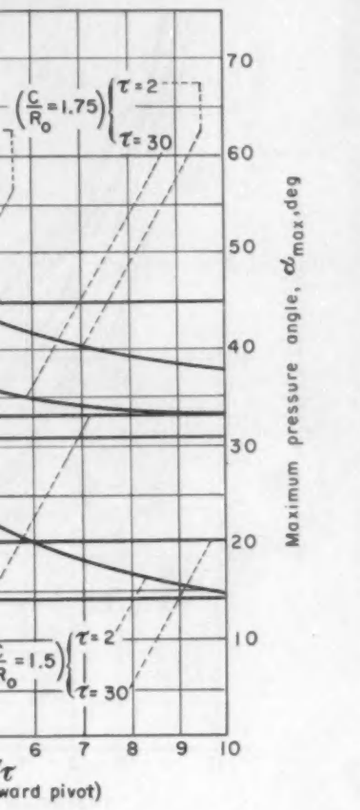
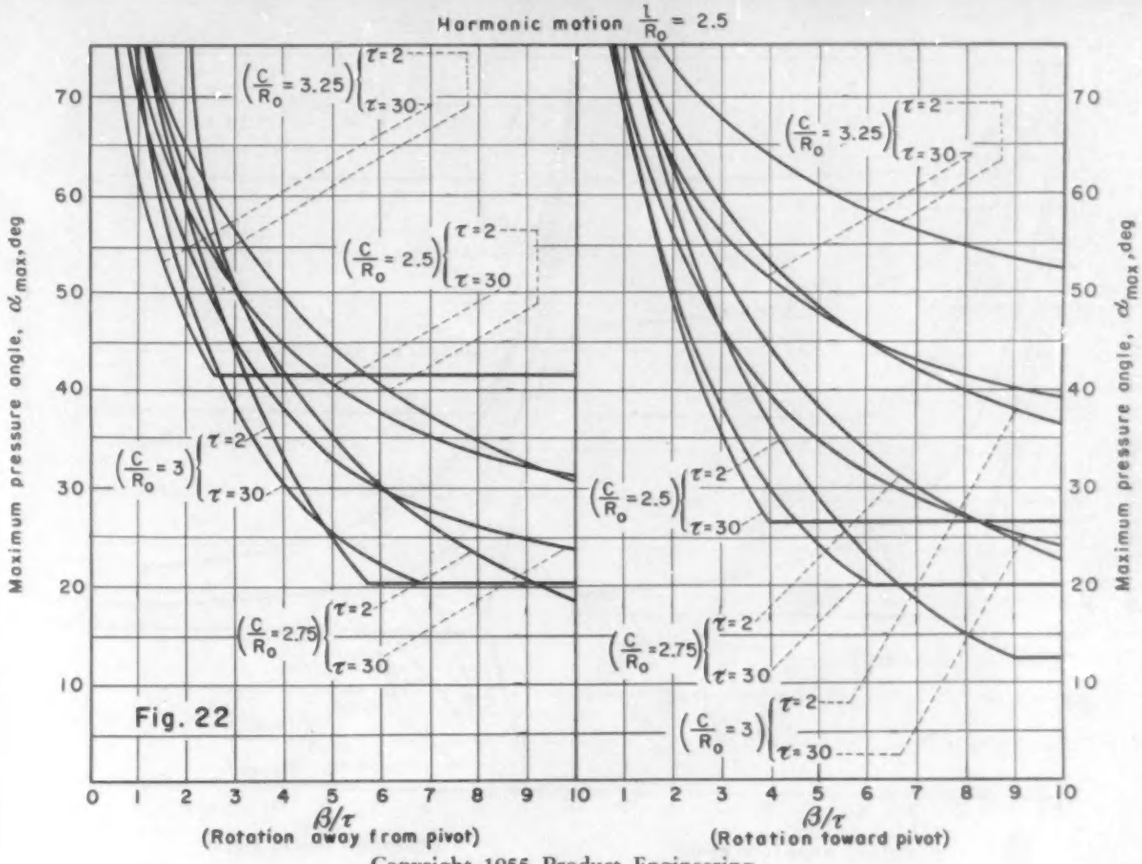

Eighth power polynomial $\frac{l}{R_o} = 2.5$
$\left(\frac{C}{R_o} = 3.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 2.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 3\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ

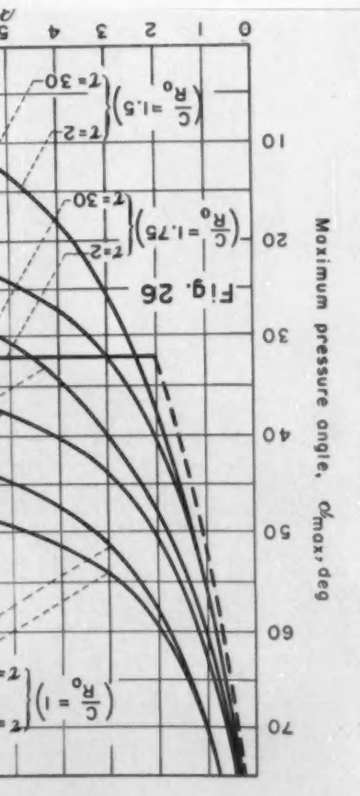
Fig. 29

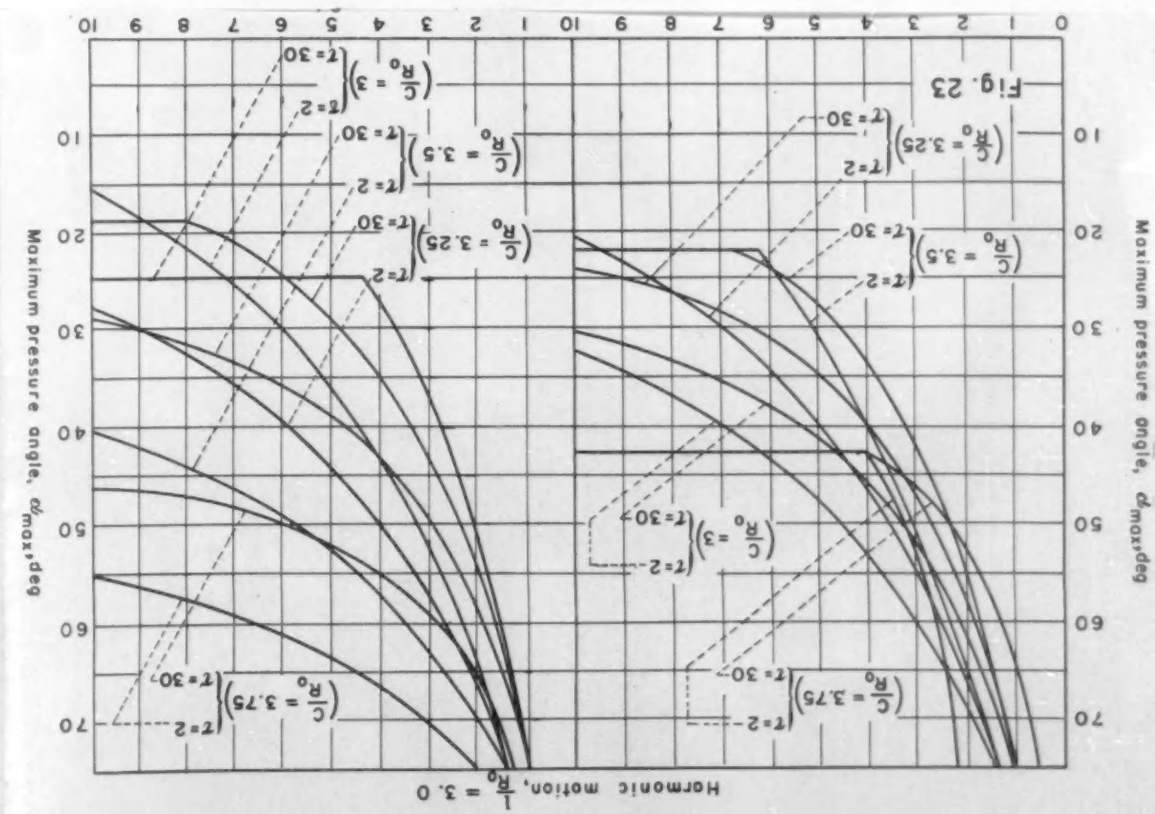

Eighth power polynomial $\frac{l}{R_o} = 1.0$
$\left(\frac{C}{R_o} = 1.75\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.5\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
$\left(\frac{C}{R_o} = 1.25\right)\begin{cases}\tau=2\\ \tau=30\end{cases}$
Maximum pressure angle, α_{max}, deg
β/τ





Copyright 1955 Product Engineering





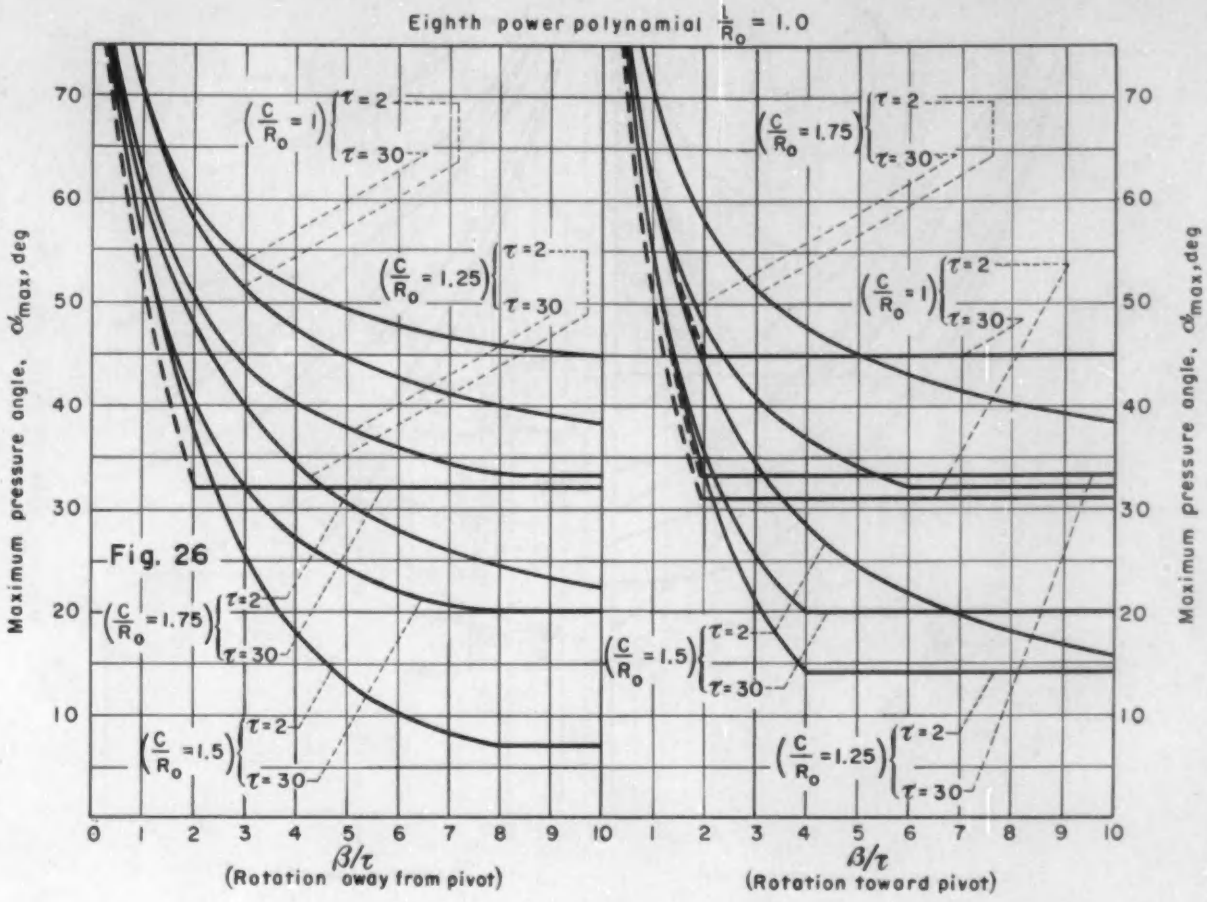

Eighth power polynomial $\frac{1}{R_0} = 1.0$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward pivot)
$\left(\frac{C}{R_0} = 1\right)$ $\tau = 2$ $\tau = 30$
$\left(\frac{C}{R_0} = 1.25\right)$ $\tau = 2$ $\tau = 30$
$\left(\frac{C}{R_0} = 1.75\right)$ $\tau = 2$ $\tau = 30$
$\left(\frac{C}{R_0} = 1.5\right)$ $\tau = 2$ $\tau = 30$

Fig. 26

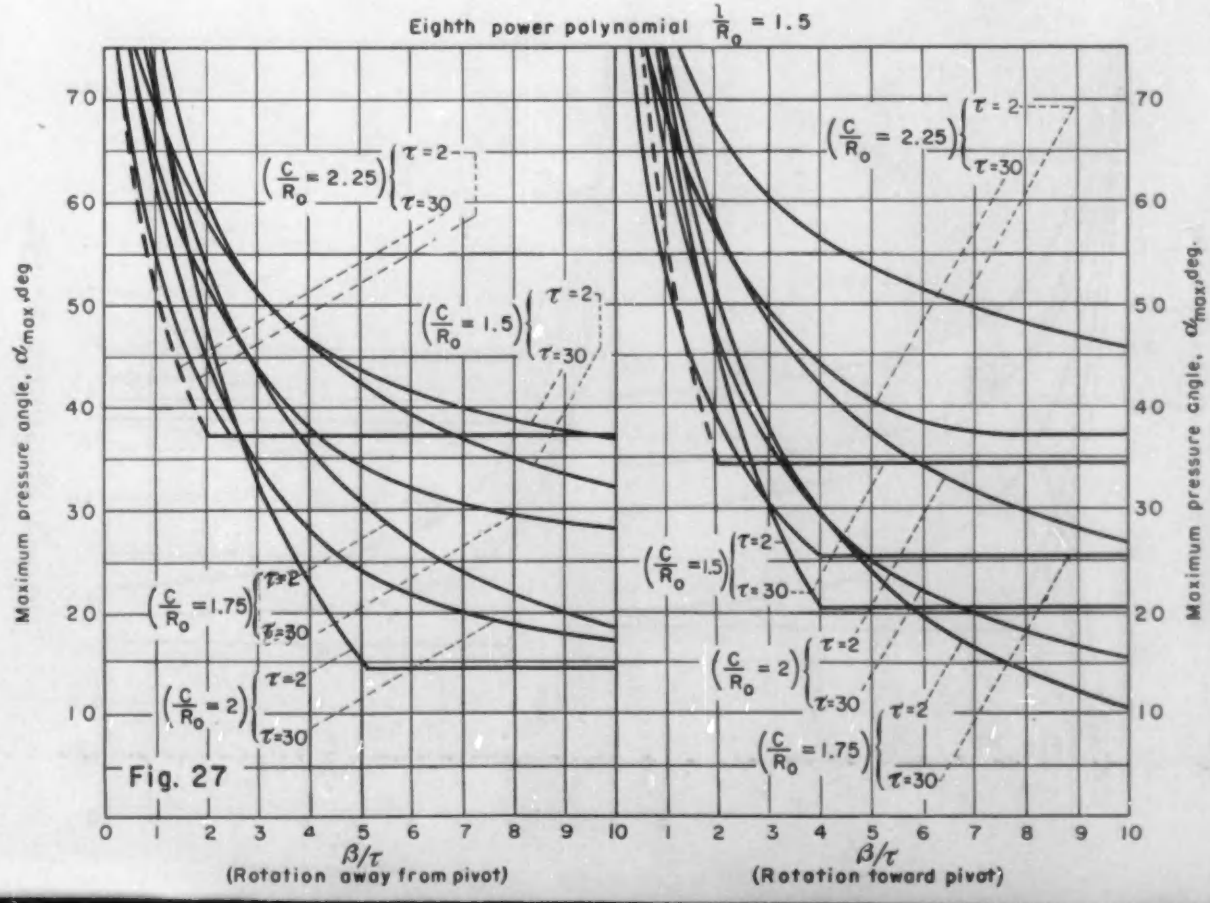
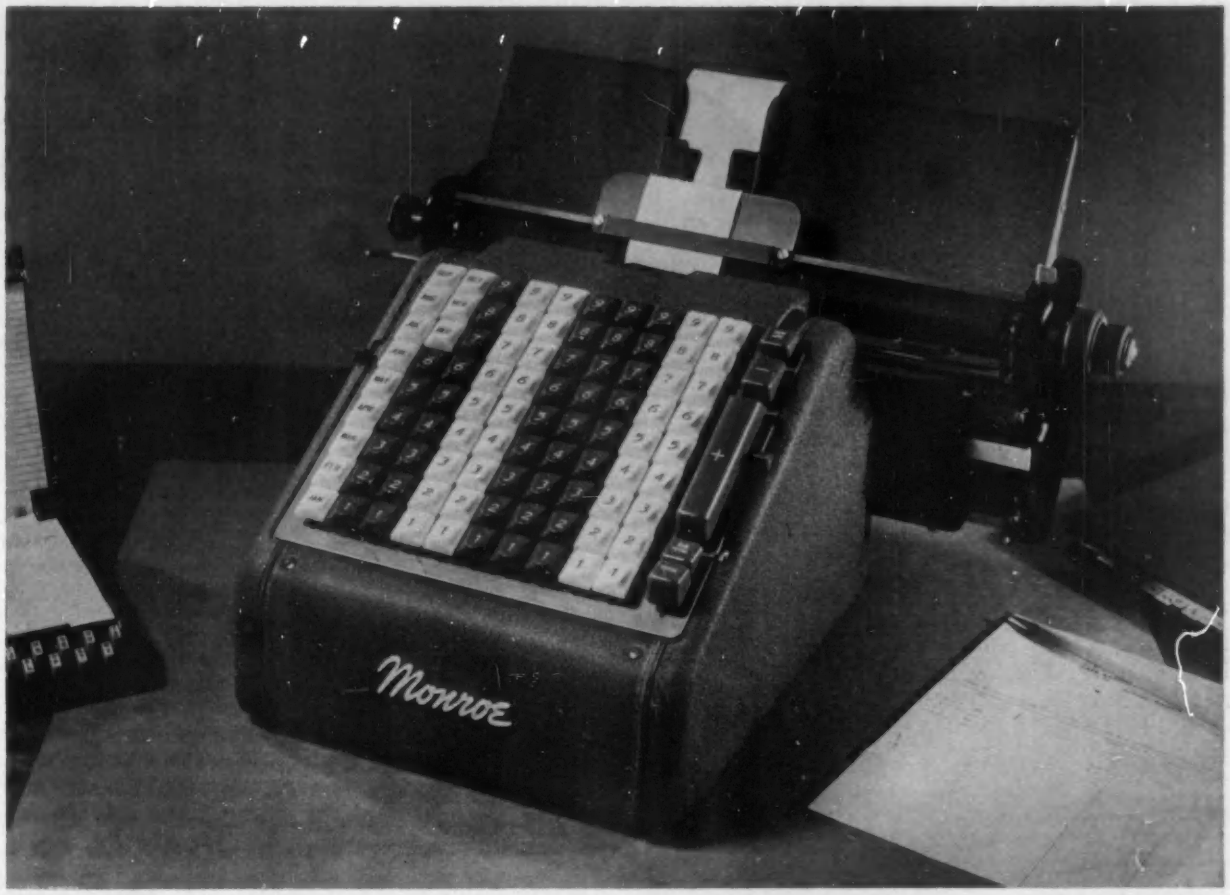

Eighth power polynomial $\frac{1}{R_0} = 1.5$
Maximum pressure angle, α_{max}, deg
β/τ
(Rotation away from pivot)
(Rotation toward pivot)
$\left(\frac{C}{R_0} = 2.25\right)$ $\tau = 2$ $\tau = 30$
$\left(\frac{C}{R_0} = 1.5\right)$ $\tau = 2$ $\tau = 30$
$\left(\frac{C}{R_0} = 1.75\right)$ $\tau = 2$ $\tau = 30$
$\left(\frac{C}{R_0} = 2\right)$ $\tau = 2$ $\tau = 30$

Fig. 27



WRINKLE FINISHES are decorative as well as durable and resistant to abrasion and discoloration. *Monroe Calculating Machine Co.*

PAINT FINISHES

Balanced paint systems decorate and protect. The growing use of resins increases the range of properties of paint. Paint technology can provide special finishes for applications where electrical insulation, antibiotic properties or heat resistance is required.

NORMAN P. GENTIEU
American Chemical Paint Co., Ambler, Pa.

PAINT FINISHES should be decorative and protective. To accomplish this two-fold purpose, paint manufacturers had to overcome many problems. These included dispersion, solubility, adhesion, resistance to radiation, electrical insulation and the design of coatings with antibiotic properties. The selection of the correct paint finish depends on these considerations as well as service characteristics such as hardness, flexibility, and gloss and color retention.

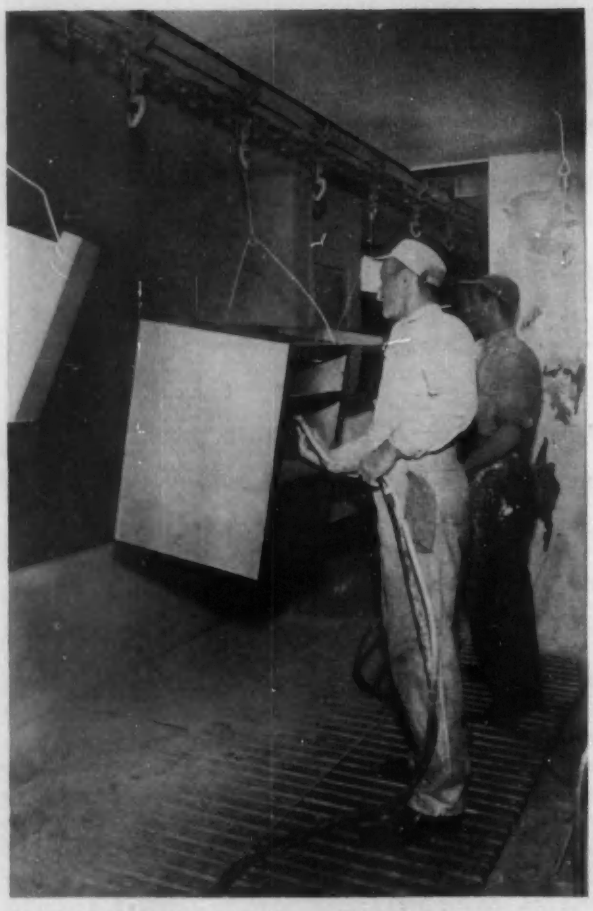
The dispersion of solids (pigments) in liquids (vehicles) must be properly balanced to produce a stable paint with a pigment of the proper fineness and consistency for optimum properties. The early paints contained very little volatile material. The use of solvents was introduced to control paint consistency and provide maximum rates of film formation when varnishes replaced drying oils as vehicles. As the use of synthetic resins increased, a number of more active solvents was developed.

A paint finish of maximum resistance to chemical corro-

sion has little value unless it also has excellent adhesion properties. Pre-paint surface treatments such as phosphate coatings help solve the adhesion problem with respect to metals. Any paint designed for outdoor use, particularly, must reflect the ultraviolet rays of the sun. At the same time, the reflectance property must not be so great that none of the warmth of the sun's rays will be absorbed by the painted part if that property, too, is required.

Organic coatings are generally used where the paint must have electrical insulation properties. These coatings often are required to withstand elevated temperatures. Antibiotic paint finishes contain toxic agents which inhibit the growth of bacteria, molds and other organisms. These paints provide protection against corrosion and deterioration of the base material by fungi or bacteria. They also prevent the loss of decorative properties of the finish caused by mildew formation.

The hardness of paint films is usually compared to glass and the finish should provide maximum resistance to cutting or scraping by sharp objects. Flexibility is the ability of the paint finish to withstand chipping or flaking when the part is operating under normal service conditions. Generally paints are required to exhibit resistance to this type of damage even under abuse. Gloss retention is the property of the paint film to exhibit the same depth and fullness during its life which is showed when first applied to the base material. Color retention is that property of the paint film to remain stable even though the part is exposed to variations of light and heat.



SPRAY PAINTING in booths can be carried out on a continuous basis. Here a number of kitchen cabinets are being enamelled.

All of these properties are important in the selection of the proper paint finish for the service conditions to which the coated part will be exposed. Interior and exterior use will be factors in the choice of a paint as well as consideration of the actual operating conditions. For example, linseed oil base paints are sometimes preferred for products that will be subjected to outdoor operations. Such paints can be used where the function of the film is primarily decorative, where lasting resistance to expansion and contraction is mandatory, and where ample drying time is available. Parts such as gutters, downspouts and awnings are often finished with linseed oil paints.

Types Of Paint

The protective organic finishes which are known as paints can be divided into four general classifications depending on the composition of the material. These are: paint, varnish, enamel, and lacquer and can be defined as follows:

Paint is a mixture of finely divided solids, or pigments, dispensed in a liquid known as the vehicle or medium. This pigmented liquid composition is converted to an opaque solid film after application as a thin layer.

Enamel is a kind of paint consisting of pigments and vehicle and characterized by its ability to form an especially smooth film.

Varnish is any liquid composition which, when applied as a thin film, dries to a homogeneous, transparent or translucent solid film, giving a continuous decorative and protective coating to which it is applied.

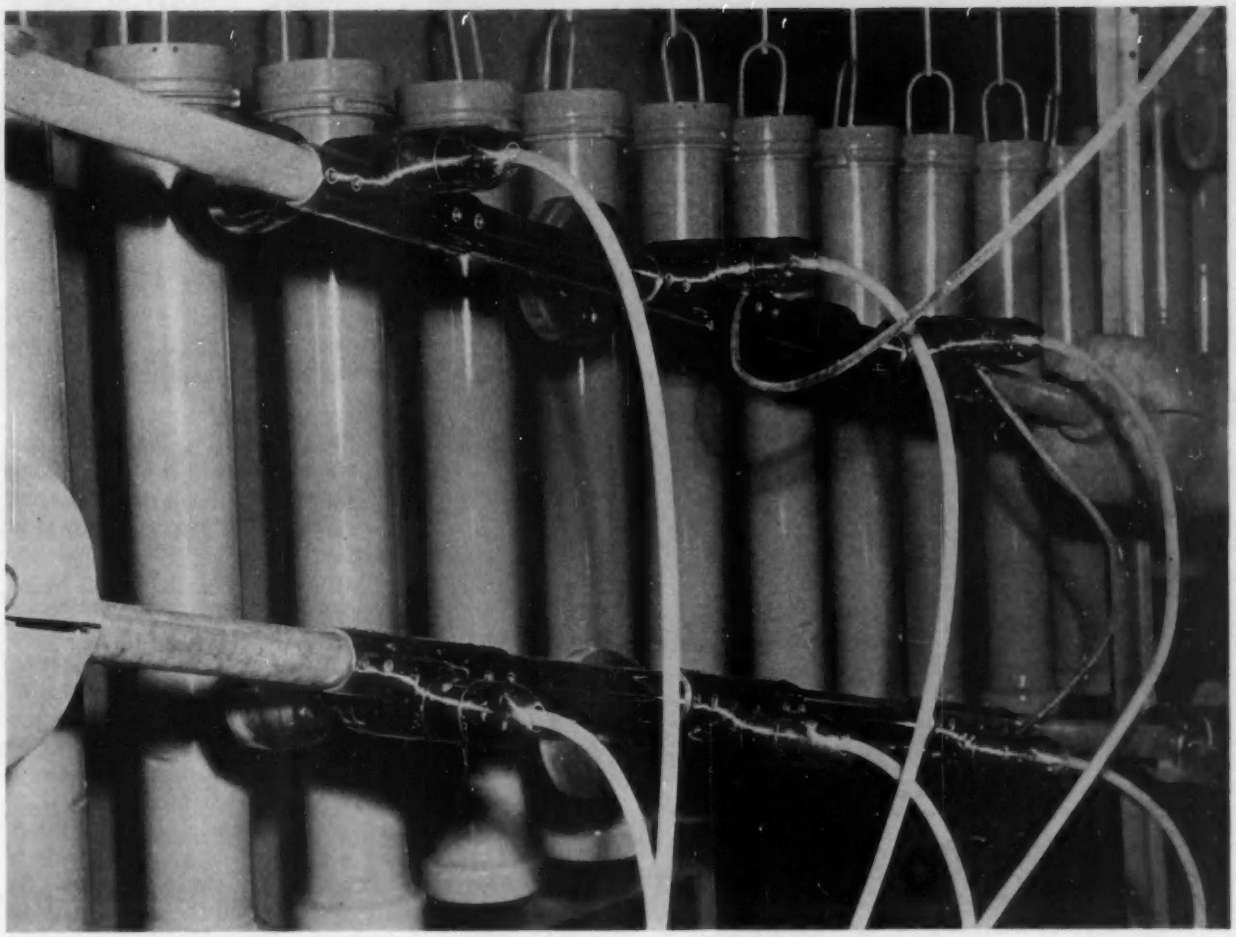
Lacquer is a liquid composition containing cellulose esters or others as the basic film-forming ingredients. Lacquer dries rapidly by solvent evaporation and forms a film from the non-volatile constituents.

Synthetic resins have become an important part of paint technology. There are two general classifications of plastics used for paint coatings; systems containing the alkyd resins and systems containing no drying oil or alkyd. The alkyd enamels have excellent service records. They are more resistant to scouring and abrasion than linseed oil paints.

The alkyd resins can be used by themselves or in combinations with other resins such as the aminoplasts. The alkyd and amine resins form the basis for the more popular automotive enamels. These systems have excellent glass and color retention, lessened chalking and sagging and diminished film shrinkage. Products efficiently covered by these resins include outdoor signs, home appliances and lawn furniture.

Some alkyds have been used as insulation varnishes because of their flexibility retained at elevated temperatures, and good properties of oil and weather resistance. Other resins having good electrical properties are the urea-formaldehydes and the melamine-formaldehydes. Finishes containing urea-formaldehyde are used in molded form for all types of electrical sockets, plugs and switches but are not generally used for insulation on electrical windings. These finishes have a broad use on such products as metal furniture, cabinets and toys.

The melamine-formaldehyde systems can be cured faster at higher temperatures than the ureas to obtain coatings



THE ELECTROSTATIC PROCESS GUN is used in the automatic spray painting of aluminum tanks.

of better hardness, strength and toughness, and improved dielectric strength. These resins exhibit generally good properties but their higher cost tends to narrow their range of applications.

Lacquers are used for finishing trucks, automobiles, signs, and furniture. Finishing with lacquer has developed into a science. One of the advantages of lacquer is its ability to dry rapidly and the fact that, in drying, no chemical change takes place. This characteristic makes such operations as painting automobiles in two colors much easier.

Lacquer is less subject to blistering and checking than enamels but must generally be protected by clear coats of wax to give good outdoor service.

For luster retention, both lacquer and enamel stand up well although enamel may lose some of its gloss once the film has been polished after weathering.

Lacquers in combination with alkyd resins are recognized as some of the most important semi-synthetic finishes available for metal products. These combinations are suitable for both air-drying and baking finishes, and for inside and outside exposure. They combine good flexibility with toughness and color retention.

Color, of course, must always remain an important consideration in the design and fabrication of any product. The lessons of color psychology are being advantageously applied for greater sales appeal, enhanced utility value, and in some instances, increased safety. The traditional white of household appliances such as stoves and refrigerators is being supplemented by other colors including black, and combinations of colors for interiors and exteriors. Color is now an important consideration.

Paints for Special Applications

In addition to the conventional paints, varnishes, enamels, and lacquers, there are a number of special purpose paints.

Latex paints, introduced within the last ten years, have attained unusual popularity and wide industrial acceptance. A latex differs from an emulsion in that it is a dispersion of a resinous solid in water rather than an organic liquid. Development work on latex paints is still needed to make these coatings suitable for general industrial use. One substantial advantage in using latex paints is that there is no fire hazard present during painting operations.

Fire retardant paints are available which can limit the rate of spreading of a fire. However, these do not afford complete and permanent protection. Such paints are used as protection for combustible materials, and occasionally for non-combustible materials such as structural steel. When used in this manner these coatings are called heat-resistant paints, and their function is to insulate the steel

against a rise in temperature which might weaken the structure.

Flame or heat-resistant paints can be of the intumescent or mastic types. Intumescent paints are used to protect wood whereas mastic paints are generally used in the protection of structural steel.

Luminescent paints have many industrial applications. Clock numerals, automobile instrument panels, advertising displays, safety markings and decorations in darkened interiors, and novelties such as jewelry, theatrical displays, and Christmas tree ornaments are a few uses for luminescent paints.

Chemical resistant paint coatings are recommended wherever part or all of the product is in continuous or intermittent contact with a corrosive solution, such as storage tanks used in the chemical, metal, electroplating, and the food industries, and for equipment in water treatment and sewage plants.

Wrinkle finishes are usually used for the protection and decoration of metal surfaces. Different designs and color effects are made possible by variations in the materials used and methods of applications.

Flock paint finishes can give the appearance of many types of non-metallic surfaces such as felt and fabric. Cotton, sisal, animal hair, silk, wool, viscose, orlon, cellophane, and saran have been used as flock finishes.

Paint Practice

Four selected case histories of paint practices in industry show the importance of protective and decorative finishing in the production of a part.

METAL CANS. Labels at American Can Co., are lithographed directly on the metal sheet which becomes part of the can itself. Thus, the litographed portion must be able to withstand a number of severe working operations. The label design must undergo the strain of can fabrication and be able to resist the chemical action of food products during canning, as well as temperature changes which take place during heating and cooling. The labels must be colorful, easy to read and have eye appeal.

While most of the basic techniques of metal lithography are relatively the same as those for paper, one distinct difference is the application of the protective varnish coating. This coating helps prevent marring and soiling of the design during fabrication of the can and also provides a glossy and attractive appearance.

In multi-color lithography, the metal plate is delivered free of grease, oil and other surface soil to the litho department in flat sheets usually ranging in size from 18x18 in. to 37x42 in. After the inked designs are applied by presses, the printed sheets of plate are baked for approximately 10 minutes at temperatures ranging from 275 to 400 F in tunel-type ovens.

On rare occasions, the plate is given a sizing coat to provide better adhesion of ink. This is done when special or unusual difficulties are encountered in lithograph or are expected later in fabrication of the plate.

In the manufacture of enamel-lined cans there are three methods used for these coating operations; spray, dip and roll. The primary method, however, for coating metal cans consists of applying the enamel to flat sheets of tin plate before the actual fabrication of the can begins.

On sheets to be manufactured into can bodies, narrow strips are left bare by the coating roller to provide for the soldering of the side seam. From the coater the sheets are immediately conveyed through long ovens maintained at a constant high temperature where the enamel is thoroughly baked, leaving only an insoluble, inert film on the tin plate. Various enamels and linings are tailored to fit the protection needs of the product packed in the container and in some cases double coatings are used.

Through high-speed, automatic mass production methods it is possible for a can manufacturer to produce up to 450 cans per minute. Approximately 33 billion metal cans are produced by the entire industry annually.

MOVING PICTURE PROJECTORS. The facing side of Eastman Kodack's new 8 millimeter Brownie moving picture projector has a decorative and functional coating applied to aluminum by a silk screen process. Here, as in all finishing techniques, the metal which receives the decorative coating is chemically clean. After the blanks have been punched they are placed in containers that are slotted to prevent scratching of the surface. The coated containers are then immersed in a petroleum solvent, rinsed in hot water, immersed in a mild alkaline cleaner, rinsed in cold and then hot water. They are then blown dry with an air hose and placed in a heated cabinet to complete the drying. The blanks are then silk-screened. Kodack's screen procedure is described as follows:

A black and white drawing is made up and a transparency of this drawing is produced on Kodalith emulsion plates. From this transparency a stencil is made. By means of Kodak's Ekpagraph method the stencil is transferred to special 16 mesh silk. This operation is actually a transfer of emulsion.

The coating is then applied to aluminum blanks which are punched and are chemically clean. In this step a standard silk screen procedure using an oil base ink (paint) is used. The first coating is baked at 270 F for 20 minutes. The second coating is applied and is baked at the same temperature for 40 minutes.

Finally, the decorated aluminum component is inspected, packed, and shipped to the assembly department.

TRACTORS. Caterpillar Tractor Co. products, upon leaving the assembly line, are cleaned with a solution of trisodium phosphate (T.S.P.) mixed with live steam to remove all dirt and grease. Approximately two ounces of T.S.P. are used per gallon of water. The water is at or near boiling temperature and steam is delivered at 45 to 65 psi. The T.S.P. water is mixed with live steam by means of a special mixing nozzle.

The tracks of the tractors are cleaned first while they are turning in low gear. After cleaning, the steamer begins at the engine and works to the rear of the machine, carefully removing all grease, dirt and oil film. The machine is then given a hot water rinse. The rinsing is done carefully so that no T.S.P. water from steaming remains on the machine. The machine is then removed from the steaming booth to be blown dry with an air hose.

All bare metal parts which are accessible are given a surface preparation by cleaning and phosphate condition-

ing. They are then washed with a solution of one part phosphoric acid solution and three parts water. The solution is applied with a brush to secure maximum scouring and cleaning and is wiped off so that no neutralizing alkali salts or oil film is left on the parts. This phosphate-conditioned metal surface increases life and durability of the paint to be applied. It also destroys rusting agents and slightly etches the metal to make a good bond between metal and paint. Solvents for metal cleaning are not used because of the fire hazard. Solvents also tend to become saturated with oil resulting in poor cleaning and poor paint adhesion.

Patent plates, gauges, glass, serial number plates and other parts of the machine which do not require paint are carefully masked.

After masking, the machine is ready for the spray booth. Spray booths are of the down-draught, water-wash type. Tractors are usually sprayed or painted with buff-modified primer surfacer.

The spray painter attempts to coat the parts but avoid excessive build-up. A normal paint thickness is one mil with never less than 0.6 mil film thickness of buff modified primer surfacer. Prime paint reduced to desired viscosity to insure proper flow under conditions of temperature and humidity at time of spraying, is prepared in the paint mixing room.

Columbia Bicycle Co.

DECORATIVE DETAILS are brushed on manually as finishing operations, on bicycle frames. This trim is an effective part of the design.

Thickness of the top coat is approximately 2 mils but never less than 1½ mils. The painter checks for runs and misses after completion of the spraying. Touching up around plates and other masked areas is completed before machine is moved to finishing floor where black striping is applied to radiator bars or grill. Raised letters also are painted black and exhaust stack is painted with aluminum paint. Transfers or decals are applied before machine is taken from paint finish room for a drying period of not less than three hours under average atmospheric conditions.

BICYCLES. Color undoubtedly plays just as important a role psychologically as the paint finish plays physically in insulating vulnerable metal from moisture, oxygen, sunshine and other harmful influences. Otherwise, bicycles and even automobiles might just as well be finished in a rugged but monotonous battleship grey.

Columbia Bicycles observe this theory of color and are painted to create an appeal to the cyclist, with a combination of lustrous, two-and three-tone color finishes and decorative patterns. All Columbia finishes are of alkyd enamel baked on at a high temperature. These provide protective and decorative coatings comparable in quality with standard automotive finishes.

On most Columbia models, the paint finish is in a basic shade of red, green, or blue, while the decorations are in lighter shades of the same colors. Decorations are usually applied to the frame head, seat mast tube, fork, fenders and chain guard.

Several painting techniques are used by Columbia. Fenders, which present the least complicated surface for paint application, are dipped manually into a tank containing a specified enamel and then hung on monorail conveyor which carries them to the baking oven. As they move away from the dipping tanks, excess paint drips off the bottom edge of each fender into a trough which carries the drippings, free of dust or other soil, back for re-use. The rate of drip is a controlled process so regulated as to leave no perceptible bead on the painted unit. Bead-free painting is a result of maintaining the viscosity of the paint at a predetermined coefficient.

The frames cannot be painted efficiently by dipping; they are spray painted in individual paint booths. The intricacy of the frame and the cylindrical contour of the tubing require special attention. The spray painter must cover every part of the frame to produce a continuous protective finish.

Decorations are applied by three different methods. Fender and frame decorations which augment the general theme of streamlining are superimposed on the elemental finish by spray painting through metal stencils which fit the convex contours of the fenders and the tubular shape of the frames. Striping is quickly and efficiently put on fenders and tubing by operators using long-bristled camels hair brushes. The speedline design and the name are applied by the silk screen method.

23 Design Tips For Sheet Metal Fabrication

Points sometimes overlooked but important when specifying sheet metal parts. Some seemingly minor considerations can affect labor and material costs in fabrication.

VICTOR J. FURIO

Production Engineer,
Metalcraft, Inc., Rego Park, N. Y.

SIMPLE-LOOKING sheet-metal designs are often more complex than they seem. To produce them may cost many times what they would if detailed attention were paid to significant cost factors. A part is shown in Fig. 1 which by careful design for economical production, is relatively inexpensive to make compared to the same part fabricated from flat sheet, corner reinforcements, angular brackets, screws, rivets, or welds.

Specific Suggestions for Reducing Costs

1. All drawings should be simple, carefully detailed, and for larger assemblies, subdivided into logically selected smaller sections. The less complicated the drawings appear to the estimator, the better the chance of receiving a low bid. Also, informative but simple-looking drawings help process the job through the sheet-metal shop with less time required for layout and assembly.

2. Use standard commercial warehouse stock dimensions, if possible, when specifying flat strip, bar angles or structural shapes. For instance, nonstandard ¼ x 1⅝ in. cold-finished flat strip might be called for on a drawing where a standard stock size of ¼ x 1¼ in. would be equally satisfactory and its use would avoid machining costs.

3. Show maximum possible tolerance on dimensions. The greater the tolerances, the better chance for lower costs. On standard shapes or cut-outs, such as shown in Fig. 2, a die charge can often be avoided by specifying absolute maximum and minimum tolerances. The sheet-metal vendor

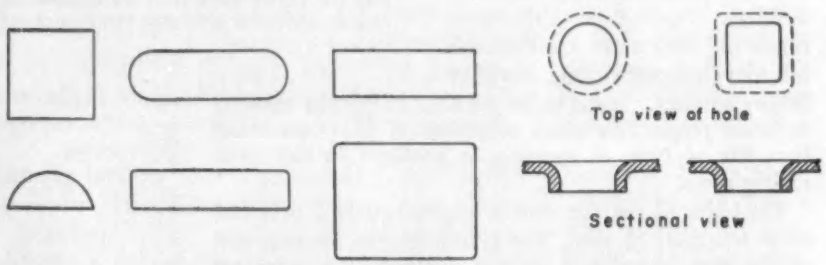


Fig. 2—Stock dies are generally available in a number of assorted sizes for the standard shapes shown at (A). Use them if possible to minimize costs. Also, for lightening holes that give reinforcement for strength while reducing weight, stock dies are available in the shapes shown at (B). Before completing drawings, check with the shop for sizes in stock, and possibly save a die charge.

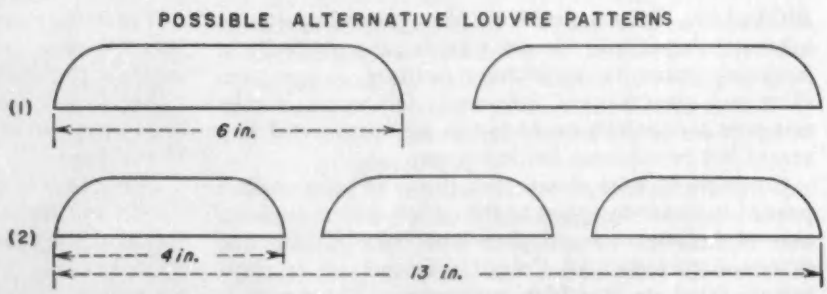


Fig. 3—Although drawings called for two 6-in. cabinet louvres, as shown at (1) above, the use of three 4-in. louvres, as shown at (2) below, would also provide the same ventilation. In this case a die charge would be saved, since the 4 in. dies were in stock while the 6 in. were not. By specifying 6 in. Louvres, or equivalent, with an explanatory note, the shop would be tipped off to a possibility for savings.

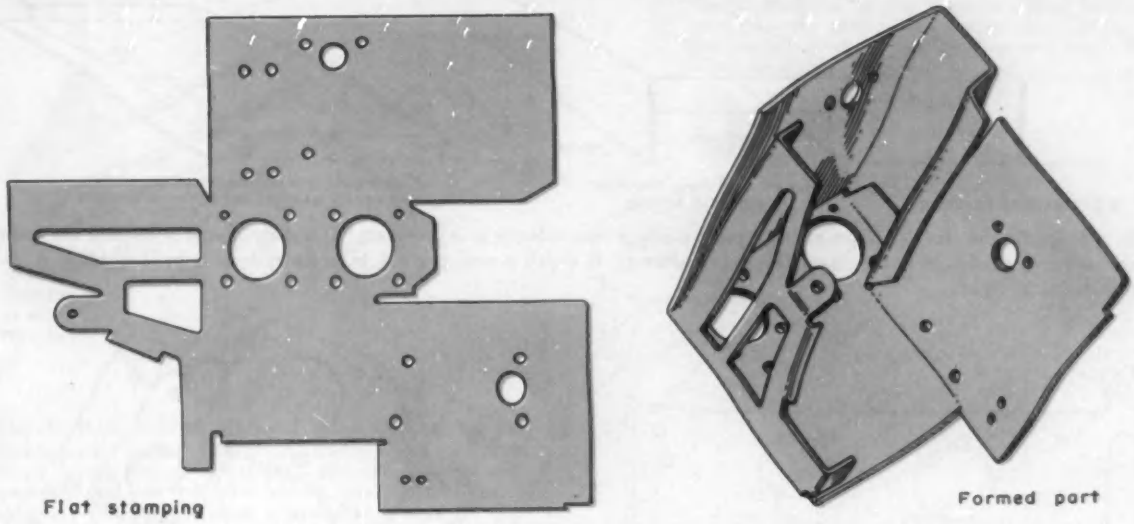


Fig. 1—By designing this complicated cover assembly as a one-piece stamping instead of two- or three-piece, 5 per cent tolerances are held without expensive jigs and fixtures; angle brackets and fastening hardware are not required; and welding is reduced to a minimum. The result is considerable saving in material and fabrication costs.

may have stock dies close enough to average requirements. Take cabinet louvres for example; a certain amount of louvring may be required for cooling which could be provided as one, two, three, or more louvres of varying size. In Fig. 3 (top) the drawing specified two 6 in. louvres side by side. The sheet-metal vendor had 4 in. louvre dies in stock which, if usable, would have saved a die charge. By agreeing to the arrangement at (2) in Fig. 3, considerable cost could have been saved without sacrificing quality.

4. Standard fasteners should be specified, if possible. Some standard nuts are shown at (A) in Fig. 4 for different methods of assembly. However, even where a particular design will not lend itself to the commercially available sizes of such fasteners, don't lose sight of their good features in specifying the required part. For one thing, the standard commercial fastener automatically lines itself up in a hole. The special spacer bar,

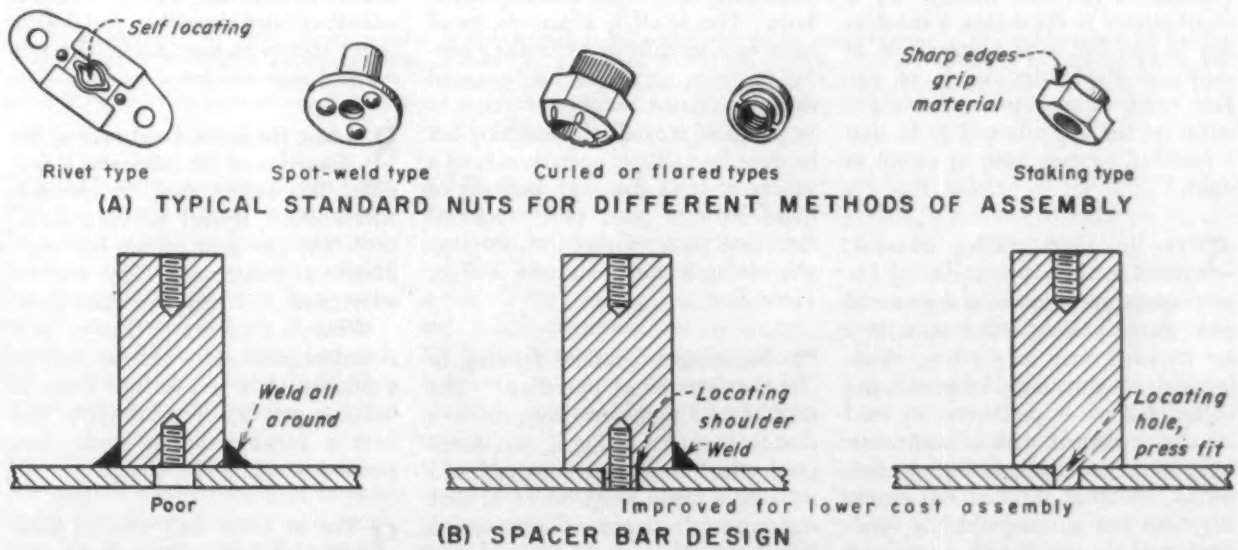


Fig. 4—When *standard* fasteners, such as shown at (A), are specified, costs are minimized. However, when special fasteners must be specified, take advantage of the important cost-saving assembly features of standard fasteners, such as locating shoulders, side play, staking provisions, etc. Careful attention to the design of such items as spacer bars, shown at (B), can reduce the cost of an assembly. The design at left requires expensive jigging for close tolerances on screw hole locations. In the other examples, screw-hole locations are automatically established in punching pilot holes with the stamping press.

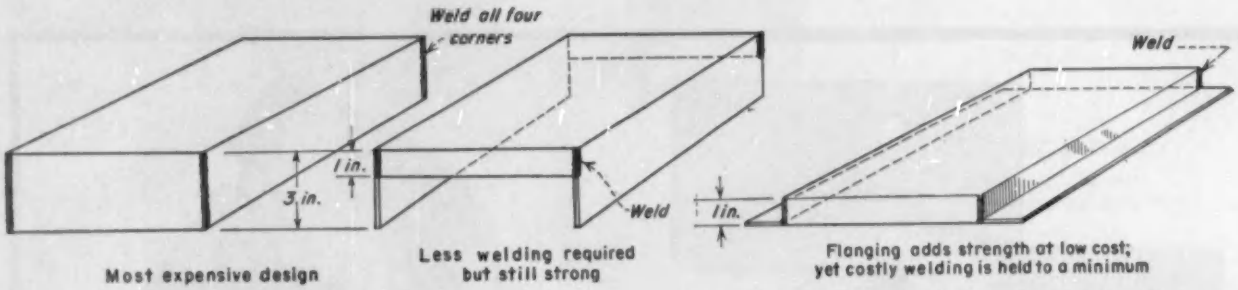


Fig. 5—By redesigning the chassis shown at left, costly welding was reduced to a minimum. If a deep chassis is desired for other than strength reasons, the design in the center may be satisfactory. If depth is unimportant, high strength with little welding is obtained by the design at right.

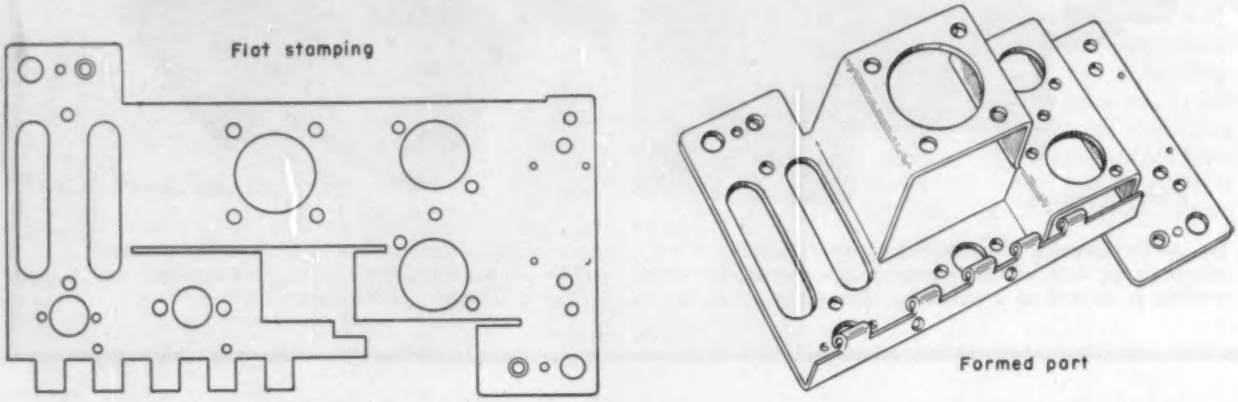


Fig. 6—Example of an intricate one-piece stamping which cost much less to fabricate than if made up of two or three separate pieces. Tolerances are easier to hold, welding is minimized, separate brackets are unnecessary, and expensive jigs and fixtures are avoided. Holes are held to 0.005 in. tolerance. Note the hinge formed by stamping.

shown in the left illustration at (B) requires some kind of holding device to locate it for welding, such as a clamp or a screw which must be carefully applied and then removed after welding. This costs money. By a slight change in the design, a shoulder can be provided to fit a larger hole, as shown in the center sketch; or, the post could be provided with a slight collar on the opposite end to fit into a punched locating hole, as shown at right.

5. Try to avoid welding wherever possible, since this is usually the most costly operation on a sheet-metal part. After welding, other operations are required, such as grinding, cleaning and straightening. A generally accepted but costly practice is to weld all chassis corners with a continuous weld as shown at left in Fig. 5. Sufficient rigidity is obtained and results are often just as acceptable by bending two of the four flanges shorter and welding, as at center or right, at less labor cost and with a savings in material. When welding cannot be avoided, try to avoid grinding.

6. Use one-piece construction where possible. Do not be alarmed by intricate notching that may be required; one special die can solve a complicated notching problem and often save many work-handling operations. The result is a part produced more economically by eliminating joining of pieces by welding or by use of fasteners. If the number of pieces to be produced is small, the notching can be done by multiple operations from a variety of stock dies. An example of quite intricate parts each fabricated from one piece of metal at considerable saving in costs, is shown in Figs. 1 and 6.

7. For hinges, consider forming in the stamping operation. The method of hinging two sections of a chassis, as shown in Fig. 7, was developed after much experimenting, and replaced a piano hinge which at best was extremely sloppy on dimensional tolerances. By the old method, the commercially available hinge was fastened to both halves of the chassis by spot welds. In addition to slop, corrosion developed between the hinge and the chassis, and the chassis wiring was difficult in such close quarters. With the new method, the hinge is formed out of the chassis itself and uses a stainless steel pin inserted after assembly of parts and wiring. Welding was eliminiated altogether, and desired closer tolerances were held. The new method also cost less.

8. Leave the inside bend radii to the discretion of the fabricator if possible. If a radius must be specified, always check against standard handbook tables to make certain the specification is reasonable. Tight radii always cause difficulty and raise costs.

Where a radii greater than an inch is desired, such as for a corner post on a cabinet, show a tolerance range as broad as possible. The fabricator may have a suitable die in stock, thus avoiding a special die charge.

9. Try to avoid ball corners with spherical radii in designing a cabinet, unless it is being *completely* tooled up. The fabrication and welding of such corners add considerably to the cost of the cabinet.

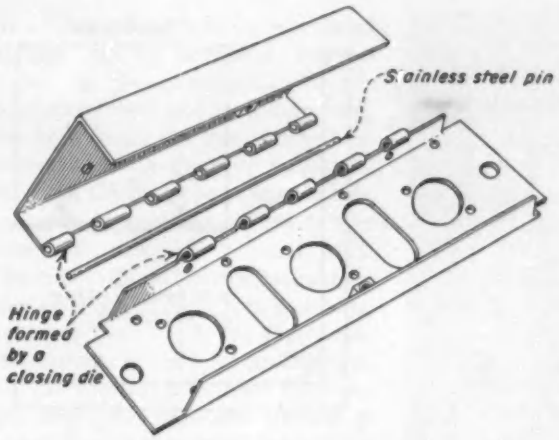
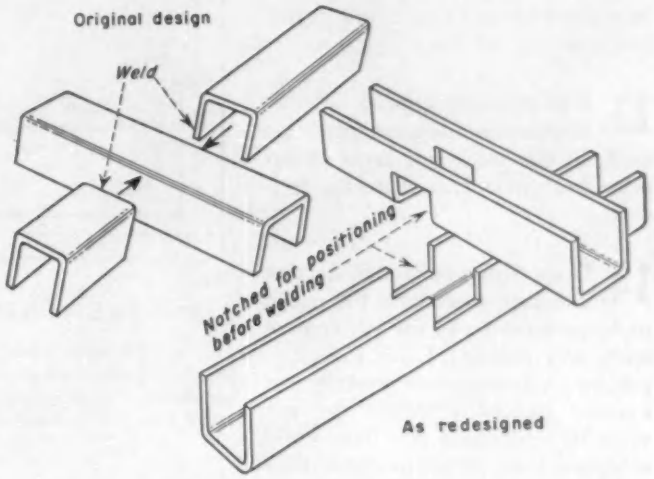


Fig. 7—How tight dimensional tolerances can be held between two hinged parts of an assembly by forming the hinge on the chassis. A stainless-steel pin, inserted after assembly of parts and after wiring, ties the two chassis together. All slop, a most undesirable feature of commercial piano hinges, was eliminated; and the cost, once the die was made, was much less per piece than for the standard hinges available.

Fig. 8—Redesign of the joint shown at left to that at right solved a serious problem of jigging for welding. The mating notch is self jigging and resulted from a simple stamping operation.



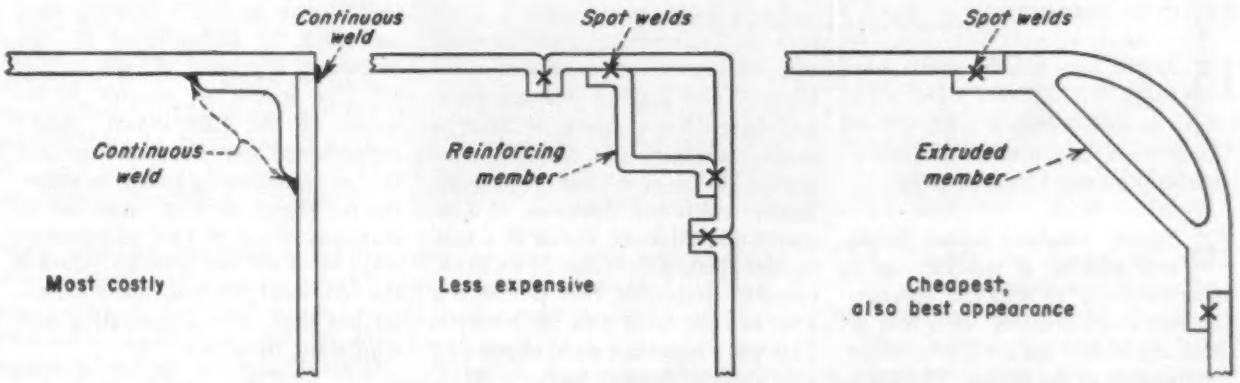


Fig. 9—A common but costly corner support is that shown at left, where an angle reinforcement is fastened in place by continuous welding. A somewhat less costly design is shown in the center sketch; yet jigging costs and difficulty in gaining access for welding the inside corners, leaves much to be desired. By using an extruded member for the corner, as shown at right, and tack welding the sides in place, strength is obtained at lowest cost; yet, if anything, appearance is improved.

10. Whenever possible, design parts to be self jigging in assembly. Butt welding of major structures, for instance, adds to the cost since welding jigs must be made to hold parts rigidly in place. Provide a mating notch, if possible, for lining up and self jigging. A good example of this is the part shown in Fig. 8.

11. Use of extruded members for corner reinforcement in cabinet design will often cut costs. Such members can eliminate much fabrication, welding, and assembly time, as indicated in Fig. 9. At right, an extruded section is used; it is the least expensive design as well as the most effective. The original design, at left, employed a $\frac{1}{4}$ in. thick back and side plate reinforced by a 2x2x$\frac{1}{4}$ in. angle continuously welded the full length of the cabinet. The welding involved, in addition to the grinding and straightening, is very expensive, and the assembly is cumbersome. An improvement is shown, at center, where the $\frac{1}{4}$ in. material is replaced by $\frac{1}{16}$ in., and the new design provides equal or greater strength; spot welding replaces the continuous welding previously required; and although somewhat greater assembly time is required, overall cost is less because of savings in material; also the cabinet is lighter.

By using an extruded member, as shown at right, all fabrication is eliminated except cutting corners to length and spot welding of the sides to the corners. The extrusions are purchased to exact specifications in standard lengths. The side plates are flat sheets. Advantages include eye appeal, greater strength, and lower cost.

12. Consider spinning possibilities, a method of sheet-metal forming often overlooked. Usually when a shape, such as shown at left in Table I, is required, the designer thinks in terms of deep drawing, and this can entail heavy die expense. In the right-hand illustration the same piece is shown designed for spinning; the only differences is a slightly increased radius. The comparative merits of drawing versus spinning for the part

shown are also given in Table I. Spinning in this case is more economical for small quantity production provided the corner radius can be increased sufficiently. The purchasing agent should be advised to send a part such as this to a spinning concern.

13. If of minor consequence whether ferrous or non-ferrous metals are used, let the purchasing agent obtain prices both ways; then make the decision.

14. In specifying perforated areas on drawings, show both the region to be perforated and the per cent of open area desired. Leave the exact pattern to the vendor if possible. An in-stock perforated-pattern die can often be used which may have round or square holes, either in-line or staggered. As long as it makes no difference, money can be saved by leaving it up to the fabricator.

15. Select and specify rivets carefully. A 17ST rivet takes much longer to install than a softer 2S or 53S rivet. A hard rivet in an inaccessible location can also raise costs.

16. Specify standard rubber blocks and gaskets, if possible. Such materials come in standard commercial sizes and diameters. It is best to check availability against the tentative requirements of the design. The tolerances shown on the drawings for rubber blocks will often determine costs. A liberal tolerance can allow a block to be saw-cut whereas a close tolerance may necessitate an expensive mold charge. The Rubber Manufacturers Association has prepared a table of commercial tolerances which can be applied to a given part, based on length, width and thickness. If a required pad thickness results in a non-standard part, such as one 1⅛ in. thick, consider laminating two pieces, one 1 in. and the other ⅛ in. for example. This will eliminate a mold charge and may improve delivery time.

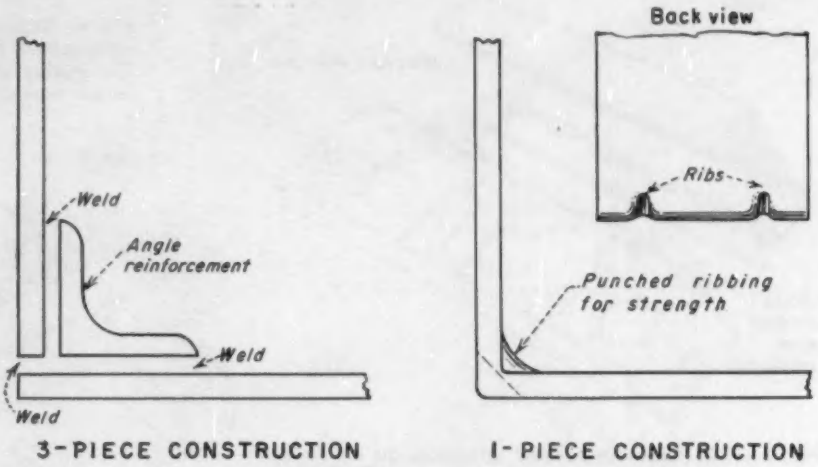


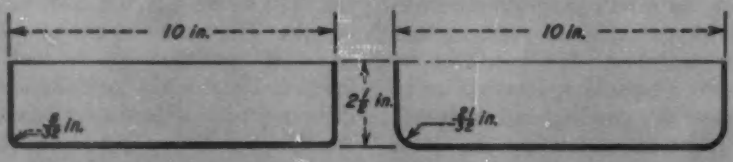
Fig. 10—In many cases, sufficient reinforcement at bends can be obtained by the simple expedient of punched ribbing as shown at right, thus eliminating expensive construction with angles or gussets. The 3-piece construction shown at left is not uncommon but is much more costly than the 1-piece redesign.

17. Specify punched ribbing for strength wherever possible. Savings in material and fabricating costs can often be accomplished by this technique, illustrated at right in Fig. 10. The double rib, punched in the corner of the part shown, greatly strengthened the piece and avoided the use of reinforcing gussets or angles. No die charge resulted, since the dimensions of the rib were unimportant and a stock die was available. Cost of the additional punching operation was far less than cost of fabricating with reinforcing members.

18. Avoid locating holes close to right-angles bends, if possible. A punched hole should always be at least 1½ × stock thickness + inside radius of bend. A hole any closer must be drilled after bending, which is a costly operation; very often a special drill jig with bushings will be required. On the other hand, if distortion is permissible on a hole close to a bend, it may be possible to punch closer than the above formula indicates. A note on the drawing, specifying the allowable distortion possible, will often result in savings.

19. Specify final finish on each assembly whether or not the sheet-metal vendor is to do the finishing. In this way the extent of required cleaning before finishing will be known and can be provided for, thus eliminating a possible second cleaning. Also, any finishing problems that could occur

Table I—Comparison of deep drawing and spinning costs for an 0.074 in. thick steel part.



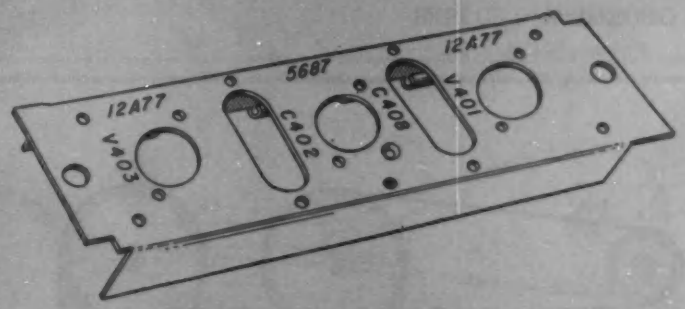
As drawn — As spun

Piece Price—dollars (in quantities shown)						
With tool costs shown separately:						
Process	100	500	1,000	5,000	10,000	Tool Cost
Drawn	.84	.75	.73	.73	.73	$1,120.00
Spun	1.07	.97	.95	.92	.91	46.97
With tools amortized:						
Drawn	12.06	2.99	1.85	.954	.842	
Spun	1.54	1.06	.996	.929	.914	

after fabrication can be caught ahead of time and be prevented. For example, on the specification for one assembly of steel and aluminum parts, the final finish was not specified on drawings sent to the sheet-metal vendor. The aluminum parts were to have an anodized finish which couldn't be done after assembly to steel parts. The responsibility for anodizing should have been passed on to the sheet-metal vendor to carry out at the appropriate time during assembly. In another case, lack of knowledge of final finish by the sheet-metal fabricator resulted in serious trouble because of the welding rod used. A 43S wire was chosen for welding an aluminum assembly to give good strength to the welded joint; however, the aluminum assembly was later given an Iridite finish. The weld turned black after finishing, and all parts had to be reworked.

Supply a set of engraving prints to the sheet metal vendor, if engraving is to be done after paint finishing. In this way, any characters which fall in inaccessible places and which may thus be virtually impossible to engrave after assembly, can be taken care of while the piece is still in the flat or at an appropriate time during assembly.

Table II—Typical comparison of costs, based on quantity of production, for two popular marking processes



Comparative Costs						
Silk Screening				**Stencilling**		
Screen Charge — $22.00 Printing Charge — (each) .12				Stencil — $6.00 Printing Charge — (each) .20		
With screens and stencils amortized:						
Piece Price—dollars (in quantities shown)						
Process	**25**	**50**	**100**	**200**	**300**	**500**
Silk Screen....	1.00	.56	.34	.23	.193	.164
Stencil.....	.44	.32	.26	.23	.22	.215

20. Consider costs when specifying a finish. Iriditing has recently been approved by both Army and Navy as an equivalent substitute for anodizing, and the cost runs about 50 per cent less. Also, iridite does not attack foreign metals on an aluminum assembly in the way anodize does and can be performed after complete assembly of non-homogeneous materials.

21. Consider sandblasting as a cleaning process. On large cabinets or weldments, sandblasting can save cleaning cost and often eliminate close grinding. Aluminum weldments, as well as steel, can be cleaned in this way. It is common practice to sandblast simple chassis and flat panels to provide a perfect bond for paint or plating finishes.

22. There is no single method of lettering or marking that is best for every job. Lettering a cabinet or chassis can be done in various ways. Stencilling may seem the cheapest and in small quantities is more economical; but as the quantity increases, silk-screening is cheaper. Silk-screening is the more professional looking and the more accurate method of marking; it will also stand up better on production runs.

Table II shows comparative costs of silk screening and stencilling for marking a small chassis. The screen charge is about four times the cost of a stencil; yet, the silk screen printing charge per part is only slightly more than half the charge for stencil printing. Thus, for the lettering called for here, stencilling is cheaper in quantities to 200. Above 200, silk screening is more economical.

23. Consult the sheet-metal vendor on a proposed design while the drawings can still be changed. Often, when a drawing is sent to a sheet-metal fabricator for price quoting, the fabricator sees ways by which the drawing might be modified to more economical production of a part. Yet, it is often too late to make changes since much expense and time would be involved. It is best to consult the sheet metal fabricator at the time the design is conceived. In this way, costly "design-for-producibility" changes can be avoided.

EDITOR'S NOTE—In addition to these practical cost-saving design tips, other ideas may be found in two previous articles in *Product Engineering* on sheet-metal design. In "Sheet Metal Design With the Dollar Sign In Mind" in October 1953, page 188, bend and hole tolerance considerations were discussed in detail; also the importance of standardizing on flange and corner-notch dimensions. Ideas for design of relief notches for right-angle bends, and location of pierced holes relative to such bends are given in "Basic Design For Small Part Stampings" in January 1952, page 162.

In a forthcoming issue of Product Engineering, the important subject of stiffening sheet metal by bead forming will be thoroughly covered. It was touched on briefly in this article under item 17 as a cost saving method for strengthening angles. It has much wider application, particularly where maximum strength-weight ratio is important. The type of beading to use depends upon the material involved, its condition of hardness, thickness, strength-weight ratio required, and the application.

Ten Types of Belt Drives

GEORGE R. LEDERER
Raybestos-Manhattan, Inc.

Fig. 1 OPEN DRIVE
(V, Flat or Poly V Belts)

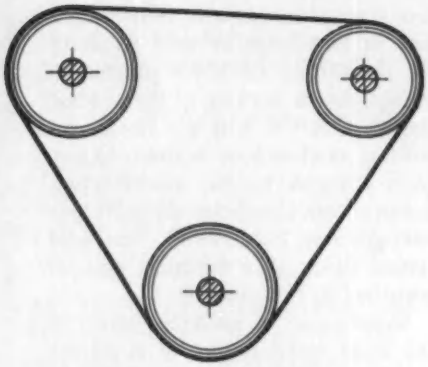


Fig. 2 THREE PULLEY DRIVE
(V, Flat or Poly V Belts)

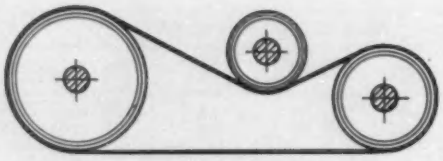


Fig. 4 REVERSE BEND IDLER
(Poly V, V, or Flat Belts)

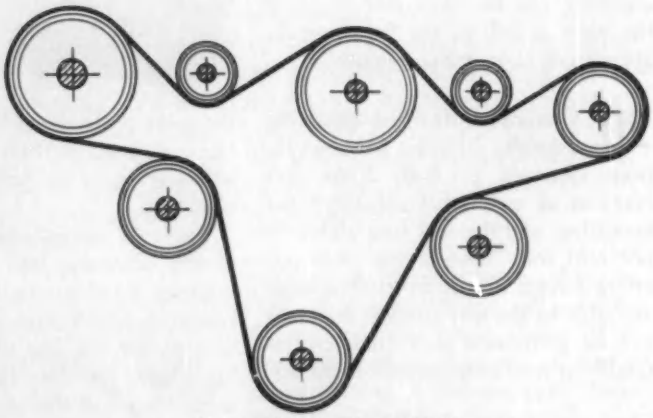


Fig. 3 SERPENTINE DRIVE
(Poly V, V, or Flat Belts)

FIG. 1—Can be either horizontal (A), or vertical (B). Used on equipment ranging from washing machines to oil well pumps. Ideal for high capacity drives; allows wider range of speed ratios than any other type. Provisions must be made for take-up (see *Product Engineering*, October 1953, pages 168-169). No minimum or maximum center distance limits other than available belt lengths.

FIG. 2—Limited in capacity to 8-10 hp because of small high-speed pulleys and limited provisions for take-up. Usually used with one unit hinge-mounted, as in automotive fan belt drives. Large belts would stretch beyond capacity of hinged unit to take up slack.

FIG. 3—Useful where several units are driven from a central shaft. The vv belt that resembles two v-belts joined back-to-back was developed especially for this drive. For vv operation all pulleys must be grooved. For regular v-, Poly-V or flat-belt operation, only those driven by the belt face are grooved, others are flat and are driven by the back of the belt. Hp requirements are from 15-25 hp. Sheaves are small, speed is slow and belt flex is extremely high, which affects belt life.

FIG. 4—Used where driver and driven sheaves are fixed and there is no provision for take-up. Idler is placed on the slack side of the belt near the point where the belt leaves the driver sheave. Idler also gives increased wrap and increased arc of contact. Applications range from agricultural jackshaft drives to machine tools and large oil field drives. Idler can be spring loaded to keep belt tight if drive is subject to shock. For maximum belt life, the larger the idler, the better.

FIG. 5—Driver and driven sheaves are at right angles; belt must travel around horizontal sheave, turn, go over vertical sheave and return. Bend must be gradual to prevent belt from leaving sheave. Minimum center distance for V-belts is 5.5 in. × (pitch dia of largest sheave + width of sheave).

For Poly-V, minimum center distance = 13 × pitch dia of small sheave or 5.5 × (pd + belt width). For flat belts it is 8 × (pitch

Although countless types of belt drives are possible, these ten will solve most industrial applications. These pertain to power transmission only; the tooth type of timing belt is not included. For each drive, suggestions for application and design pitfalls are given as well as speed and capacity ranges.

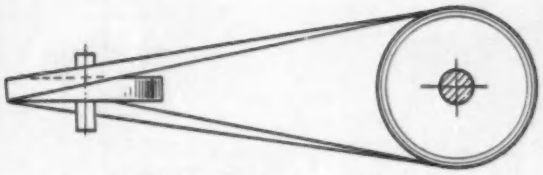


Fig. 5 QUARTER-TURN DRIVE (OPEN)
(Poly V, V, or Flat Belts)

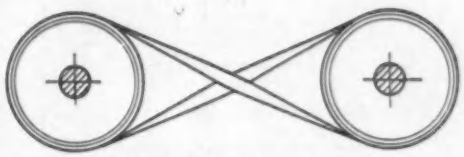


Fig. 7 CROSSED BELT DRIVE
(Flat Only)

dia + width). V-belt sheaves must be deep grooved and close matching is essential. Speed usually ranges from 3,000-5,000 rpm; hp from 75-150.

FIG. 6—Similar to Open Quarter-Turn but has higher capacity with shorter centers and increased wrap. Tracking is a problem with flat belts. With Poly-V drive, speed ratio is unlimited. Angle of entry (angle between belt and a line perpendicular to face of the sheave) is limited to 3 deg or less.

FIG. 7—Limited to flat belts because either V-belt or Poly-V would rub against itself and burn or wear rapidly. Desirable only where the direction of rotation must be reversed such as on planers, woodworking tools in general and line shaft drives.

FIG. 8—Used where driver and driven sheave cannot be on the same plane. Has same center distance and angle of belt entry limitations as Quarter-Turn. Drive can be open if take-up can be accomplished at either end or it can be fitted with a reverse bend idler, but not an inside idler. Angle between shaft can be from zero to 90 deg.

FIG. 9—Especialy developed for drill presses and special applications where driver and driven sheaves are at right angles to each other and yet on the same plane. Can operate around a corner or from one floor to another. The center sheave is 90 deg from the driver and driven sheave and acts as an idler. Twists affect belt life.

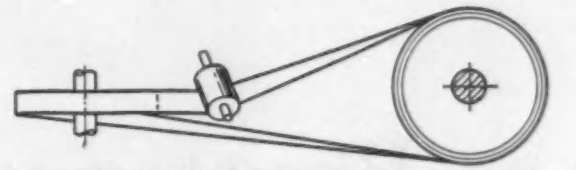


Fig. 6 QUARTER-TURN DRIVE (REVERSE BEND IDLER)
(Poly V, V, or Flat Belts)

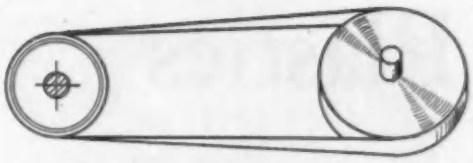


Fig. 8 ANGLE DRIVE (EIGHTH TURN)
(Poly V, V, or Flat Belts)

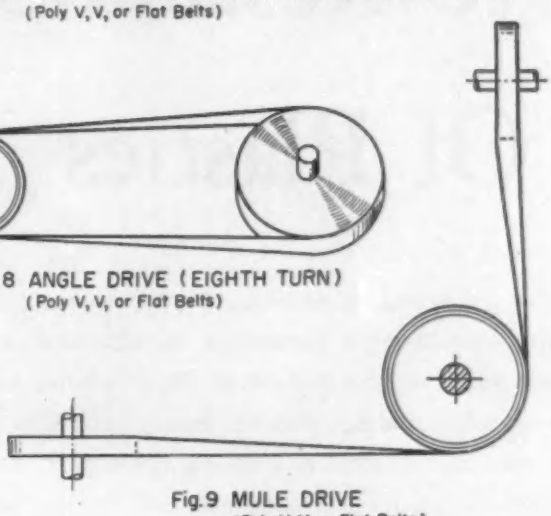


Fig. 9 MULE DRIVE
(Poly V, V, or Flat Belts)

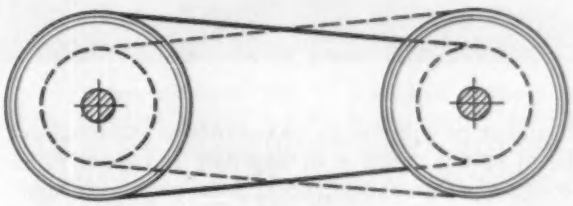
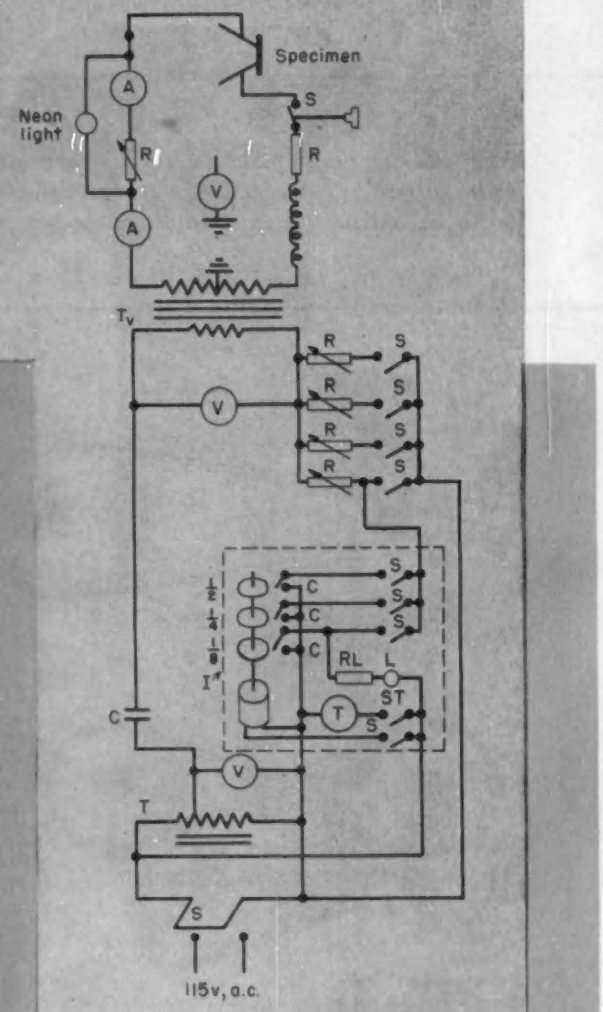


Fig. 10 VARIABLE SPEED DRIVE
(V Belts Only)

FIG. 10—Sheaves must be grooved to change the pitch diameter for variable or adjustable pitch operation. With two sheaves and one belt, it is possible to have a range of four different speeds. Widely used on propulsion drives and cylinder drives on agricultural combines and machine tools. Drive has same high capacity and advantage as standard open drive, with wider speed range. They are mostly single belt drives 1¼ to 2 in. wide. Small pulleys are not advisable. Most applications require special vari-speed cylinder or traction belt.

Fig. 1 - ASTM D495 - 48T Test Circuit

A – Ammeters
C – Contactors
I – Interruptor assembly
L – Indicator lamp
M – Motor
R – Resistors
S – Switches
T – Timer
T_V – High voltage transformer
V – Voltmeters



Arc Resistance Of Plastics

Failures by arcing at ordinary power voltages and tracking—progressive formation of electrical conducting paths on the surface of the insulation—are investigated. Among plastics materials, resistivity alone provides no clue to tracking resistance. Data here rate 13 plastics insulating materials for arc resistance and tracking characteristics.

C. F. SPIERS and W. C. WIKSTRAND
Analytical and Testing Department
American Cyanamid Company, Stamford, Conn.

THE FAILURE OF ELECTRICAL INSULATION to withstand exposure to electric arcing is an important consideration in the design of electrical equipment. Some small scale tests, such as the ASTM arc test and its modifications have been designed to simulate service conditions. These leave much to be desired, but with proper standardization and interpretation they have been found helpful in determining the arc resistance and tracking characteristics of plastics insulation.

The important factor behind these test methods is the susceptibility of materials to the formation of conducting paths when exposed to different types of arcs and leakage currents along the surface. The term "tracking" is used in the sense of the definition stated by Yarsley and Grant (see references at end of article) where, "Tracking denotes the progressive formation of electrically conducting paths which are produced on the surface of a solid insulating material by the combined effects of a tangential component of an electrical field and of deterioration in electrical leakage resistance caused by external agencies." In other words, a track is an electrically conducting path.

In arcing tests, insulating materials are subjected to the impingment of a spark or arc on the surface. In tracking tests, current passes along the surface or through a layer of contaminant on the surface. Some relationship has been observed between tracking resistance and composition. The commonly accepted conclusion is that failure of plastics materials under arcs result from decomposition while for inorganic materials, failure results from fusion. Warren (see list of references) points out that materials with low carbon content have less tendency to tracking. Olyphant (another reference) stresses that the nature of the arc discharge and the arcing current also are factors.

Arcing and Tracking Tests

The standard arc test is the ASTM 495-48T Test Method. It has been found, however, that no single test evaluates completely the tracking qualities of various plastics

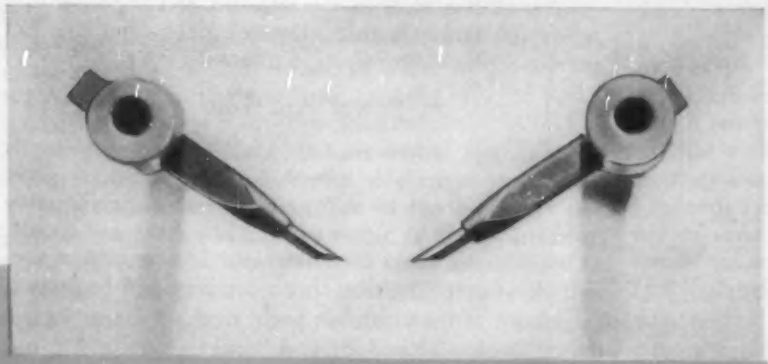


Fig. 2—ASTM D495-48T Electrodes

Table I—Sequence of One-Minute Current Steps

Step	Current ma.	Time Cycle	Approx. Rate of Heat Generation, watts	Total Time, sec.
1/8–10	10	1/4 sec on, 1 3/4 sec off	3	60
1/4–10	10	1/4 sec on, 3/4 sec off	6	120
1/2–10	10	1/4 sec on, 1/4 sec off	12	180
10	10	continuous	24	240
20	20	continuous	34	300
30	30	continuous	45	360
40	40	continuous	56	420

materials. Modifications of the ASTM test have helped to provide additional useful data in characterizing the anti-tracking quality of a material. These modifications include the continuous arc, the rotary arc, the power arc and radio frequency corona studies. The revised Admiralty tracking test and the American Cyanamid rotary tracking test are modifications designed to supply additional data on tracking characteristics of plastics electrical insulation materials.

ASTM 495-48T Test Method

This test is essentially a high-voltage, low-current type of arc test which evaluates the relative abilities of insulating materials to resist tracking when exposed to this type of arcing. The test does not rank materials when subjected to other forms of arcing such as high voltage at high currents, low voltage at low or high currents, dc voltages or the effects of contaminants. The intent of the test is to simulate service conditions combining high arc voltages and currents in the order of ten milliamperes.

Fig. 1 shows in detail the primary and secondary sections of the 12.5 kv test circuit used in this method. Intermittent arcing in the secondary results from the opening and closing of the primary circuit by the motor driven device. Current control resistors in the primary provide the currents in the secondary.

The 60-sec sequence steps in Table I indicate the periodicity and show that the severity of the arc is increased from step to step. This cycling was devised to show materials which under this test have low arc resistance. The electrodes are made from $\frac{1}{16}$ in. tungsten rod with tips ground to a 30 deg angle to the axis. The electrodes (Fig. 2) are mounted in the assembly so that they are in the same vertical plane inclined at 35 deg from the horizontal with an included angle of 110 deg between their axes. A $\frac{1}{4}$ in. spacing is maintained between the tips of the electrodes.

The arc resistance of materials is rated in two ways. In the first, the total elapsed time of operation of the test until failure is recorded. Usually this end point is quite definite, as shown by the formation across the dielectric of a conducting path and the disappearance of the arc into the material. A second rating is obtained by dividing the breakdown voltage of the tracked path by the breakdown voltage of the same area before the arcing test was started. A measure of the insulating value remaining in the damaged area is thus obtained.

Continuous Arc (Modified ASTM)

In this, a modification of the standard ASTM test, an arc of increased intensity is obtained by eliminating the intermittent steps in the standard test. Continuous currents of 10 and 20 ma have been used to indicate the performance of materials under sustained arcing.

Rotary Arc Test

A rotary arc tester (Fig. 3) is used in conjunction with the standard ASTM test for experimental, development and control purposes. In this test, a molded plastic disk (4 in. x $\frac{1}{8}$ in.) is bolted to a turntable shaft which is rotated at a rate of $\frac{3}{4}$ rpm. The electrodes and the constants of the standard ASTM test are maintained. A continuous arc of either 10, or 20 ma is used so that no interrupter mechanism for timing is necessary. This test is carried out by bringing the electrodes in contact with the surface of the mounted specimen starting the rotatable shaft motor and turning on the arc switch. Whenever the material breaks down and conducts, the arc switch is shut off for a few seconds until the carbonized path has moved by; then the arc is again turned on to continue this test.

An arbitrary set of conditions has been established for this test as being an adequate measure of the quality of the molding material. These are: first, a maximum of three revolutions for each test; second, the test is stopped when five breakdowns have occurred in any one revolution. In those instances where the number of breakdowns in a revolution is less than five the arc is switched off and then on

again in the succeeding revolution to jump those breakdown paths which have occurred previously.

For the development of materials for arc applications, a need was indicated for this type of test in addition to the "time-for-failure" information provided by the ASTM test. The corroborative results of a number of tests on experimental and control samples made by both methods lead to the conclusion that the rotary arc test supplies a measure of the frequency of occurrence of areas of low arc resistance in a given sample. Experience has shown that regardless of the thoroughness of blending, moldings which consist of a mixture of two types of resin contain definite areas which have arc resistant properties characteristics of one or the other type of component resin.

Rarely is an average value found by the ASTM test; if one resin component has good arc resistance and the other poor, the arc resistance results will be grouped in two separate classifications.

There are no problems connected with materials which exhibit uniformly low ASTM values or a sufficient proportion of low values to be readily detectable in ten tests. Instances where it is necessary to differentiate between a molding which contains no areas of low arc resistance and one in which poor areas occur very infrequently present problems for decision. Since molded parts with such characteristics, when employed for electrical insulation purposes, are potential sources of failure for the entire equipment, a test such as this to insure quality of materials is needed. The rotary test has successfully fulfilled the requirement of exploring a test area equivalent to a large number of test spots in the standard ASTM test with a substantial saving in time. Data obtained from this test are also applicable to wiping contract devices.

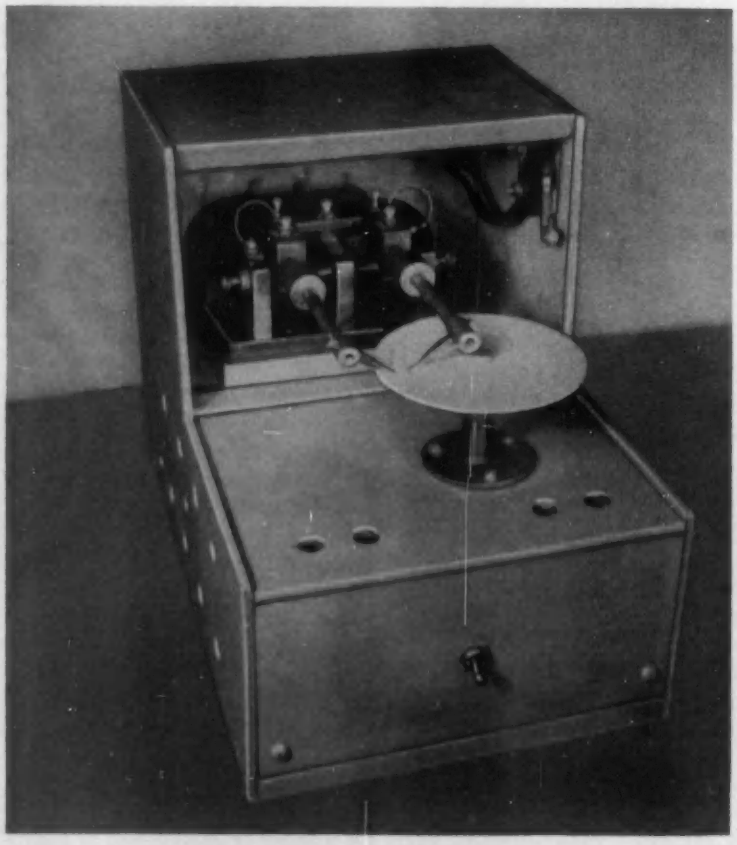


Fig. 3—Rotary Arc Tester

Power Arc Test

Martin and Hauter cited the need for finding materials which were better able to withstand the ranges of power arcs brought about by the use of increased concentration of electric power at higher voltages in present day aircraft. In applications where insulating materials are used as supports for current limiters, circuit breakers, and contactors, breakdown of the insulation could render these protective devices ineffective and thus increase the probability not only of losing the main power supply, but of creating a direct fire hazard.

Test samples were prepared by installing fuse clips on standard 60-amp limiter blocks. Copper links were applied to the fuse clips such that their ends were nearly touched. Fine wires were soldered to the bars for the purpose of fusing and starting an arc. To simulate service conditions, line voltage supplied by standard aircraft alternators (3-phase, 400 cycles, 208/120 v) was applied across the adjacent terminals of the fuse clips. For single alternator tests the fault currents were approximately 800 amp; a current of 2500 amp was used for the four-alternator tests. In most cases the line-to-line voltage (phase A to phase B) applied to the fault was 200 v. Recovery voltage was 300-350 v. Failure was considered to have occurred when either the material erupted into flames or conducted current along its surface.

Corona at 3.5 Megacycles

In his study of radio frequency arc resistance of Olyphant substituted a current supply at a frequency of 3.5 megacycles for the power frequency employed in the ASTM test. Poor consistency and reproducibility of results were obtained, primarily because of the difficulty of maintaining a constant arc current of 10 ma at this frequency. More favorable results, however, were obtained in radio frequency corona studies.

These tests were carried out by supplying 7.5, 10, 15 and 20 input to a 4 in molded disk of material. The specimen is mounted on an insulating support 2½ in. from a grounded copper sheet. A flat-end tungsten rod normal to the test specimen makes contact at its center as one electrode. The point of failure in these tests was determined by the sudden appearance of tracks or the dendritic patterns which might be more readily described as "treeing".

Revised Admiralty Tracking Test

A tracking test similar to the Detroit Edison and Admiralty tests has been proposed by Grant and Ives and reviewed by Yarsley (see references). Certain modifications and refinements of the latter test have been suggested in an attempt to improve their utility and obtain more reproducible and significant results. A diagram of the ap-

paratus is shown in Fig. 4. The test set consists essentially of a base of hardwood with a metal sole-plate, a vertical steel rod, to which are attached two supports, one of nonconducting material for the electrode system, and the other for the glass capillary and saline solution reservoir system.

The electrode system consists of an outer electrode fashioned from a brass ring of square cross section. This electrode is positioned such that it is concentric with the inner electrode which is of straight brass wire, with the lower end ground flat and square. Suitable connections are made to the power supply by means of flexible conductors.

A flat-ended needle is attached to the electrode arm such that its tip is 0.25 in. above the ring electrode and equidistant between the inner and outer electrodes. Test solution is contained in an inverted flask to maintain a constant level in the funnel. The desired drop size of 0.024 g of test solution is attained by use of a No. 11 SWG needle, adjustment of the angle the needle makes with the vertical and the concentration of the wetting agent used in the test solution. The desired drop-rate of one drop per 8 sec at 68 F is achieved by adjustment of the height of the funnel and the use of a suitably dimensioned glass capillary. The test solution is made up of 2.5 g each of pure sodium chloride, a wetting agent and distilled water to 1,000 milliliters. The electrode system is connected to the test circuit in series with an adjustable resistor 200 to 250 ohm and a 0-1.5 amp ammeter and a 230 v, 50 cycle supply.

A shorting switch to by-pass the electrodes is provided for calibration of the circuit before initiation of the tracking test. The procedure followed for a typtical test is to check the dropping rate of the test solution, short-circuit the electrodes, adjust the current to exactly 1 amp and then shut the current off. Three drops of solution are then allowed to fall between the concentric electrodes and the current is switched on. Further drops are allowed to fall until the specimen tracks, with drop No. 1 being the first drop after switching on the current. Failure of the material occurs when the ammeter reading passes 0.7 amp and stays above this value during a complete 8 sec interval. Tracking resistance is reported as the number of drops to complete the test. A specimen which requires 2n drops for failure is considered to have twice the tracking resistance of one requiring only n drops.

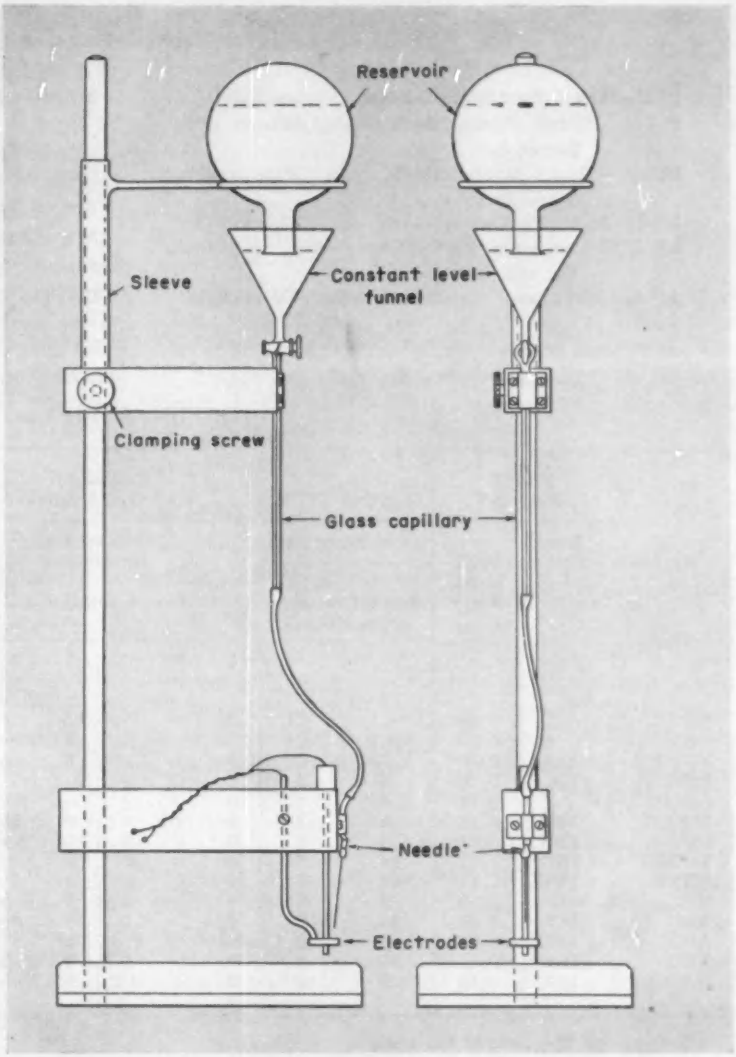


Fig. 4—Revised Admiralty Test Apparatus (Reproduced from ERA Technical Report, Ref. L/T 237, British Electric and Allied Industrial Research Assn.)

Tracking Speed (Olyphant)

The rate at which tracks grow has been investigated by among which are tracking sensitivity and tracking speed. Olyphant. The standard ASTM test evaluates the composite effect of a number of properties of a material The test devised to evaluate the latter property provided means for increasing the gap between test electrodes by a specified distance after a tracked path had been initiated. Initially, a 10 ma current is used to form a well carbonized path between electrodes with a $\frac{1}{8}$ in. spacing. With one electrode remaining fixed the second is withdrawn $\frac{1}{4}$ in. from the track. The time required to track $\frac{1}{4}$ in. of the previously undamaged material is taken as an inverse measure of tracking speed.

Rotary Track (American Cyanamid)

Another tracking test uses apparatus identical to that used in the Rotary Arc test and employs the standard ASTM circuit. In this test with the electrodes in a fixed position, a continuous current of either 10 or 20 ma is applied to a specimen until the material fails as in the standard ASTM test. With current flowing in the tracked path, the specimen is rotated at the rate of $\frac{1}{4}$ rpm until the current reappears in the air in the form of an arc. The number of seconds that the material tracks with time recorded from the moment the specimen starts to

Table II—Code for Materials Listed in Tables III and IV

PFC—Phenol Formaldehyde resin, Cellulose Filler
PFMa—Phenol Formaldehyde resin, Mineral Filler, Source A
PFMb—Phenol Formaldehyde resin, Mineral Filler, Source B
MFC—Melamine Formaldehyde resin, Cellulose Filler
MFACC—Melamine Formaldehyde resin, Alpha-Cellulose and Cellulose
MFM—Melamine Formaldehyde resin, Mineral Filler
MFMG—Melamine Formaldehyde resin, Mineral Filler and Glass
UFAC—Urea Formaldehyde resin, Alpha-Cellulose Filler
UFC—Urea Formaldehyde resin, Cellulose Filler
AM—Alkyd resin, Mineral Filler
AG—Alkyd resin, Glass Filler
PEG—Polyester resin, Glass Filler
DAPM—Diallyl Phthalate resin, Mineral Filler

Table III—Arcing Tests

Material	ASTM D495-48T		Modified ASTM		Rotary Arc American Cyanamid						Power Arc		Corona at 3.5 x 10^8 cycles			
	Arc Res.	Surf. Break Ratio	Continuous Arc		Failures Per Revolution						Boeing Aircraft No. of Arcs Alternator		Olyphant Watts Input			
	Av. Sec. to Fail		10 ma Average Seconds to Fail	20 ma Average Seconds to Fail	No. of Revolutions								7.5 Seconds to Fail	10 Seconds to Fail	15 Seconds to Fail	20 Seconds to Fail
					1	2	3	1	2	3	1	4				
					10 ma			20 ma								
PFC	2	0.06	<1	<1	5	—	—	5	—	—	1	—	7.6	3.3	1.9	1.2
PFMa	4	0.09	<1	<1	5	—	—	5	—	—	—	—	25.3	18.2	5.8	2.8
PFMb	180	0.09	<3	<1	5	—	—	5	—	—	1+	—	—	—	—	—
MFC	106	0.19	6	3	0	0	0	0–2	5	—	1+	—	—	—	—	—
MFACC	124	0.21	8	4	0	0	0	0–1	5	—	—	—	—	—	—	—
MFAC	128	0.23	8	3	0	0	0	0	5	—	—	—	6.8	5.4	1.2	1.9
MFM	174	0.22	14	7	0	0	0	0	3–5	5	6	—	25.9	8.8	3.7	2.8
MFMG	186	0.22	14	5	0	0	0	0	0	0	—	6+	—	—	—	—
UFAC	100	0.51	15	7	0	0	0	0	0	5	—	—	2.9	3.1	2.3	1.9
UFC	110	0.54	9	5	0	0	0	0	0–5	5	—	—	—	—	—	—
AM	187	0.06	25	8	0	0	0	0	0	0	2	—	>200	32.7	5.2	3.3
AG	157	0.05	10	3	0–1	0–5	0–3	0	5	—	1	—	—	—	—	—
PEG.....	180	0.11	16	4	0	0	0	0	3–5	5	—	—	—	—	—	—
DAPM	132	0.10	5	2	0	0	0–2	0	3–5	5	—	—	—	—	—	—

Refer Table II—Code of Materials

rotate, is taken as a measure of the susceptibility of a material to this type of tracking. Short tracking times in this test connote resistance to tracking.

Discussion of Test Results

Before discussing the results obtained from the various tests just described, it must be emphasized that there is no single test which can evaluate completely the track and arc resistance of an insulating material. If a single test is desired its design must be shown to simulate closely that application for which the insulating material is intended. Experience has shown that a fair index of the anti-tracking qualities of a material can be deducted only after the material has been subjected to a number of quite different tests. The code adopted for designating the materials is shown in Table II.

A study of the data shown in Table III shows that when various organic plastics are evaluated according to the standard ASTM test, in general, the mineral filled materials receive the highest ratings while the cellulose filled materials are intermediate in value. Exceptions are phenolic materials which can be intermediate in arc resistance and apparently very sensitive to resin formulation and filler, as the variaton between two mineral filled materials shows. With the conditions of the standard test remaining the same, but increasing the severity of the 10 ma arc by applying it continuously, low values are obtained for the mineral filled phenolic resins; melamine resinous materials follow the behavior indicated by the standard test, cellulose filled urea resins are equivalent to mineral filled melamine resins; mineral filled alkyd resins are superior to the rest to a degree not indicated by the standard test; the polyester resins and diallyl phthalate resinous materials are of average quality with a characteristic behavior as indicated by the standard test. By increasing the continuous current to 20 ma the materials in general are ranked in the relative order indicated by the standard test.

The surface breakdown ratios, measures of the effective insulation remaining in the tracks, do not correlate with the arc resistance values. Little if any resistance is left in phenolic resin tracks. On a relative basis the melamine resins have average breakdown ratios even though the min-

eral filled type has a superior arc resistance rating. Tracks in urea resins have exceptionally high resistance even though arc resistance is average in quality. Alkyd resinous materials appear to be abnormally low while polyester and diallyl phthalate resins are fair in this respect.

The tracks of those materials which are rated intermediate to good by arcing tests of this type have certain similarities. A crater-like indentation is usually found in the area where the tip of the electrode makes contact with the specimen. As indicated by Olyphant pitting takes place at the electrode, with consequent eruption and erosion of the material around the electrode. This type of action appears to form an area which is resistant to tracking until a temperature is reached where tracking proceeds by fusion. In phenolic type materials this pitting does not usually occur and the characteristic of the resin is such that it fuses readily and is highly conductive.

High surface breakdown ratios appear to be associated with materials like urea-formaldehyde resins where the ash in the track is crumbly or flaky and has moderate resistance in this state. According to Vieweg and Klingelhoffer this ash is a conductor when compacted. Ash from materials with low surface breakdown ratios is presumably more compressed and hence more conductive.

The results generally obtained from the rotary arc test at 10 ma, which is an approximate rate of heat generation of 24 w, show no differences between the materials. In those cases where sporadic failures are indicated it is presumed that these materials are prone to have areas of high and low arc resistance. The phenolic materials, however, fail consistently and consequently do not rate highly in this test. When a 20 ma continuous current with an approximate rate of heat production of 34 w is used the materials rank approximately in the order indicated by the standard ASTM test. The glass-mineral-filled melamine resins and mineral filled alkyd resins are outstanding in that no failures were obtained while the performance of cellulose filled urea-formaldehyde resin was remarkably good.

When sustained intense heating is encountered as in the power arc tests, mineral filled and glass-mineral-filled melamine-formaldehyde resins show remarkable resistance to this type of arcing. The same performance would have been expected of mineral filled alkyd resins if these materials were judged by the standard ASTM test. The results of these tests illustrates the importance of evaluating materials under conditions quite similar to a specialized application.

The results of the corona tests which were run at the frequency of 3.5 megacycles and various power levels are interesting. The phenolic resin materials show remarkable resistance to this type of corona, the mineral filled material especially shows excellent performance at all power levels. The other materials appear to be more sensitive to increase in power output. Mineral filled alkyd resins, especially, show a rapid rate of decline as the power is increased. Cellulose filled urea-formaldehyde resins which have consistently shown good anti-tracking properties, track readily even at low power levels in this test. At the highest power level used in this test the materials are grouped rather closely.

The tracking tests in Table IV are of two different types. In the revised Admiralty test, which is typical of the "salt-water" type test, deterioration of an insulating surface is brought about in a manner which it is felt resembles the mechanisms which initiate tracking in service. This method has the advantage of not only comparing materials in their tendencies to track but also their tendencies to yield (track-forming) material in the presence of electrolytes at relatively low temperatures.

Although the data from this reference were meager, they serve to indicate how this form of tracking resistance in phenolic resins is affected by differences in filler and the results to be expected from a different resin system such as a melamine-formaldehyde resin.

The Rotary Track and the Tracking Speed tests indicate the degree of track and whether a fresh area of material is apt to track readily when a track has already been initiated in an adjacent section. There is fairly good agreement in the data obtained by these two methods. Urea-formaldehyde resin is outstanding in its ability to resist tracking. Cellulose-filled melamine resins appear to be equally good by the Rotary Track test and intermediate in the Tracking Speed test. Mineral filler apparently facilitates the propagation of a track once initiated as evidenced by the results obtained with the melamine, alkyd, polyester, and diallyl phthalate resinous materials. The phenolic resin materials appear to track readily.

Deterioration produced on the surfaces of the materials by the Rotary Arc and Track tests is shown in Figs. 5 and 6. Rotary Arc tests at 10 ma show: no failures for alpha-

Table IV—Tracking Tests

Material	Revised Admiralty No. of Drops	Rotary Track American Cyanamid 10 m.a. Seconds Tracked	Rotary Track American Cyanamid 20 m.a. Seconds Tracked	Track Olyphant 10 m.a. Secs. to Track ¼"
PFC	10	Cont. Flashback	Cont. Flashback	0.3
PFMa	17	"	"	0.8
PFMb	—	"	"	—
MFC	—	40	2—>60	—
MFACC	—	2	2—>60	—
MFAC	—	1	2	1.8
MFM	>200	26	13	1.0
MFMG	—	14	15	—
UFAC	—	1	2	4.8
UFC	—	2	2	—
AM	—	15	27	—
AG	—	20	39	—
PEG	—	18	17	—
DAPM	—	17	25	—

Refer Table II, Code of Materials

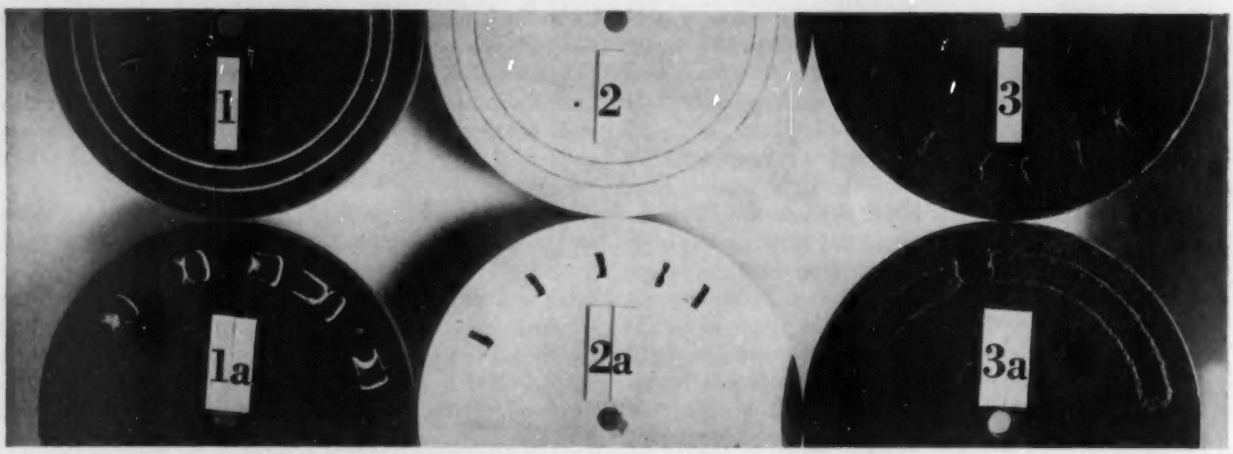


Fig. 5—Deterioration Produced by Rotary Tests, 10 milliamperes. Rotary arc 1, 2, 3; Rotary track 1a, 2a, 3a. (1) Alpha cellulose filled Urea-formaldehyde resin; (2) Alpha-cellulose filled Melamine-formaldehyde resin; (3) Mineral filled Phenol-formaldehyde resin.

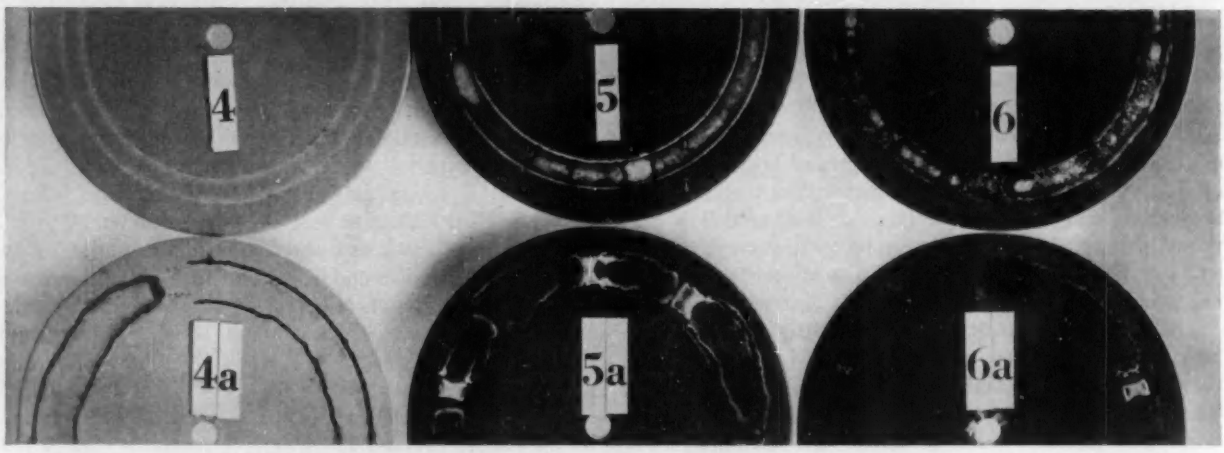


Fig. 6—Deterioration Produced by Rotary Tests, 20 ma Rotary arc 4, 5, 6; Rotary track 4a, 5a, 6a. (4) Mineral filled alkyd resin; (5) Mineral filled Melamine-formaldehyde resin; (6) Mineral filled Diallyl Phthalate resin.

cellulose filled melamine-formaldehyde resins, Sample 2, and typical tracks on mineral-filled phenolic resinous material, Sample 3. The parallel paths on Samples 1 and 2 are caused by local heating from the electrodes and are non-conducting.

Rotary Track tests performed at 10 ma on the same materials are designated by the subscript "a." The darkened areas on Samples 1a and 2a are the well carbonized paths produced by the continuous 10 ma currents before the specimens were rotated. There is little, if any, evidence of tracking progressing from the initial tracks. The continuous parallel tracks which were produced on Sample 3a propagated from the initial track. As the breakdown process continues in this material, conducting paths which bridge the parallel tracks produce a pattern similar in appearance to a ladder.

Samples in Fig. 6 were subjected to Rotary tests employing a 20 ma. current. Arcing tests produced slight decomposition from heat but no tracks on the mineral filled alkyd resinous materials, Sample 4; moderate decomposition from heat and tracks on the mineral filled melamine-formaldehye resinous material, Sample 5; excessive decomposition and tracks on the mineral filled diallyl phthalate material Sample 6. These materials tracked in varying degrees evidenced by length of the conducting paths formed on Samples 4a, 5a and 6a.

REFERENCES

V. E. Yarsley and W. J. Grant, "Tracking in Solid Insulating Materials: A Critical Resume," *ERA Technical Report*, Ref. L/T 177, Brit. Elec. and Allied Ind. Res. Assoc. (1948).

H. H. Race and F. W. Warner, "Measuring the Arc Resistance of Insulating Materials in Air," *General Electric Review*, reprint, p. 8, February 1935.

H. Warren, "Insulation," *J. E. E. E.*, 1940, 87 No. 528, p. 588.

M. Olyphant, Jr., "Arc Resistance: (1) Tracking Processes in Thermosetting Insulating Materials," *ASTM Bulletin*, p. 60, 65, April 1952.

"Tentative Method of Test for High Voltage, Low-Current Arc Resistance of Solid Insulating Materials," ASTM Committee D-9, March 1953.

T. J. Martin and R. L. Hauter, "Arcing Tests on Plastics," paper presented before 1954 SPE Convention in Toronto.

M. Olyphant, Jr., Princeton Laboratory Report 18G, "An Investigation of Arc Resistance," pps. 56, 75, 78, July 14, 1950.

W. J. Grant, G. C. Ives, and V. E. Yarsley, "Tracking in Solid Insulating Materials: Method for Testing Susceptibility to Tracking," *ERA Technical Report*, Ref. L/T 237, Brit. Elec, and Allied Ind. Res. Assoc.

R. Vieweg and H. Klingelhoffer: ETZ, 1942, 63, p. 237.

ADHESIVE BONDING

Factors which complicate the specifying of bonding materials and processing techniques; why optimum results are not often obtained when adhesives are selected from a catalog; and the proper approach to selection of the correct formulation and process for a particular requirement.

JEROME L. BEEN
Vice President & Technical Director
Rubber & Asbestos Corp., Bloomfield, N. J.

HISTORICAL BACKGROUND

Adhesive selection and bonding techniques have changed as a result of recent developments in adhesive formulations. The aircraft and automotive industries use adhesives on a large scale in assembly-line operations, and have been primarily responsible for the rapid developments and changing concept in adhesive selection and application. However, there has been a major difference in the design approach by engineers in these two industries.

The automotive approach has been a carry-over from carriage manufacturing where wood and leather were the primary materials. Nails, upholstery tacks and screws were the standard fastening devices; hardly any glue was used—not even animal glue. The all-steel body and the assembly line brought about some changes; yet, at first, wood nailing strips were used to apply upholstery. In an effort to eliminate the wood, as well as to facilitate assembly, reduce costs, and speed production, those industries were investigated which were working with similar materials for similar assemblies — i.e., luggage, leather-working, textile, handbag, and shoe industries—all of whom were attaching leather, fabrics, leatherette, and the fabric finishing materials without mechanical fasteners. For many years, these industries had been attaching their materials to metal, wood, and other rigid structures by the use of ordinary glues and rubber cements of simple formulation.

The automotive industry thus adapted existing techniques and materials to serve their requirements, and although there have been occasional changes in the formulations used, there has been no basic change in techniques of application. Yet, today, the industry is finding increased application for metal-to-metal and plastic-to-metal adhesive bonding with many of the same properties required by the aircraft industry.

The aircraft approach was from an entirely different point of view, and it was obviously impossible to use the same adhesives and the same techniques. Principally there were more exacting requirements for structural integrity of the adhesive bond under most stringent conditions. New formulations and new application techniques were obviously required. A joint research program by industry and the government has been carried on to find suitable adhesives, and techniques for application, to speed production and assure a satisfactory bond during the life of the basic equipment.

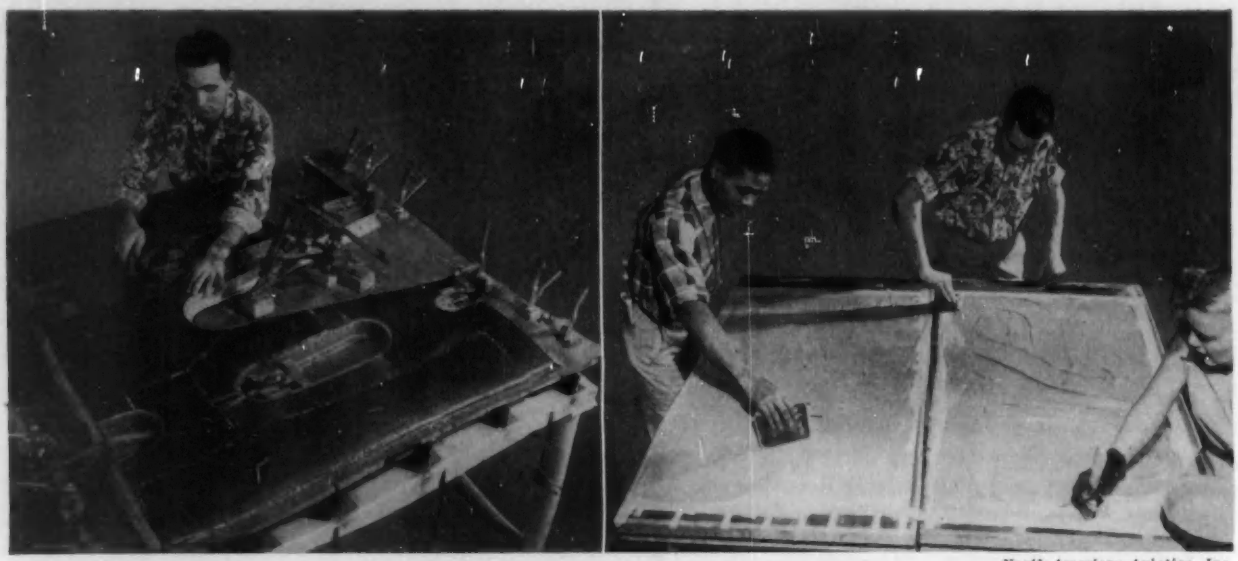
FOR ADHESION, the assembly being bonded must contain an adequate quantity of the adhesive in tacky form to make perfect contact with the "adherend" surfaces. An effective adhesive—adherend system or assembly is one which will retain its strength in adhesion after either chemical or physical changes have taken place which leave the adhesive no longer tacky.

Because it is necessary to have the adhesive in liquid form to make a bond, normally non-tacky (solid) adhesives must be rendered tacky by reducing them to the fluid state by application of heat, pressure, heat and pressure combined, or by use of solvents.

Of real concern is what happens when the solvent dries up, when the adhesive cools, or when a chemical "cure" or vulcanization takes place, all of which reduce the tack. The strength of the bond finally depends on: (1) chemical, or "Van der Waals" forces between the components; (2) cohesive strength of the components and adhesive; (3) degree of mechanical interlocking due to surface roughness, fibrous structure, etc.; and (4) the effective area of the bond, a function of the degree of contact and wetting as well as mechanical entanglement.

The final result is frequently difficult to predict. Consider the following examples, for instance:

The dextrine film on the back of a postage stamp, when solvent-activated with water, becomes tacky. When applied



North American Aviation, Inc.

Fig. 1—(Left) Assembling aluminum honeycomb core on bonding jig preparatory to application of adhesive-coated glass cloth. After the cloth is placed over the core, adhesive is applied to the top side of the cloth before placing the aluminum skin in place. The same procedure is followed on the other side of the core to complete the sandwich. Curing of the adhesive takes place in special ovens. (Right) Spreading the epoxy paste adhesive on glass cloth preliminary to placing between aluminum honeycomb core and skin in aircraft sandwich panel fabrication. Since several spreaders work together, inspection is automatic. Commercial automatic paste spreaders are available for applications where their use would prove economical and practical.

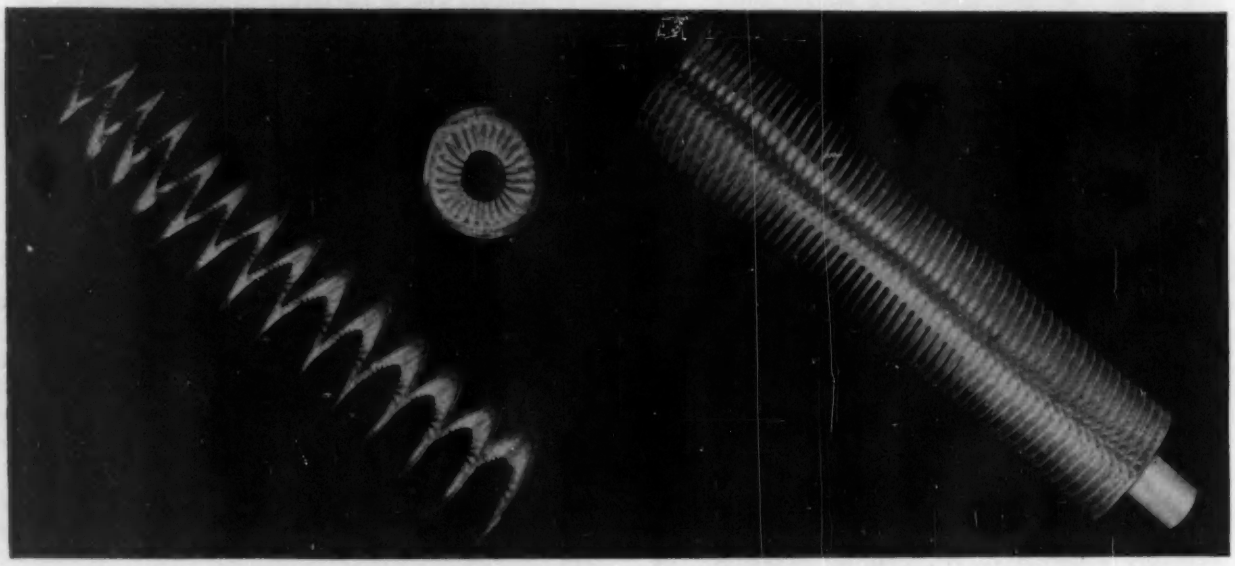


Fig. 2—The aluminum-to-copper fin-tubing heat exchanger assembly (right) is made by slipping the aluminum fin (left) over regular copper tubing and securing in place with a low-viscosity, high-solids paste adhesive.

to a paper envelope, the water dries out through the fibers of the paper, and a strong bond results due to both fibrous entanglement and chemical affinity. If the stamp is applied to smooth glass, the bond is strong due to chemical affinity with the oxygenated materials present; but if applied to a tinned can, the stamp adheres only as long as it is wet and then falls off.

A certain crude-rubber cement containing sulfur, accelerators, and carbon black, is used to bond together either pieces of cloth, unplated polished steel, or brass-plated polished steel. The bond when used on cloth is 5 lb per in. mechanical anchorage; with the steel and the brass plate, it is only about 1.5 lb since there is neither chemical nor mechanical bond, but only the tackiness of the uncured rubber. After vulcanization by heating at 300 F for 20 minutes at 300 psi, the cloth bond rises to 12 lb per in., due to the increase in cohesive strength of the rubber. With the plain steel, there is no bond, since the tack has disappeared; but with the brass-plated steel, the strength goes up to 60 lb per in., resulting in tearing of the rubber, due to a chemical reaction that takes place and forms a strong compatible complex film of sulfides.

Thus, to make an adhesive workable it must be either a solution, an emulsion, a liquid which is polymerisable, a solid which is heat-reactivatable, or a solid which is solvent-reactivatable. Cure, vulcanization, polymerization

and cross-linking are all means for producing chemical reactions which increase the cohesive strength of the adhesive. Pressure is employed (a) to assure adequate contact between all members of the system, (b) to hold the parts together while the solvent is drying out or while a cure is taking place to give the adhesive its strength, or (c) to offset the destructive effects of gases and steam evolved during the cure of condensation-reactive adhesives, such as most curing rubber, phenolic, elastomer and vinyl-phenolic alloys, and amine-aldehyde (urea, melamine).

Forms of Adhesives

Adhesives are available in two basic forms: (1) dispersed in a fluidizing carrier solvent, either organic or aqueous; and (2) free of volatile carrier. The latter, often called the "100 per cent reactive system," includes films, solvent-free pastes, powders, and hot melts.

The first type of adhesive is most common because air drying can be employed in many cases to remove the carrier fluid for development of a good bond; also, common paint brushes or spray guns can be used to apply them.

The carrier-free adhesives are rapidly gaining favor as the most practical for assembly-line structural bonding. They provide the strongest bonds obtainable with any one adhesive. In this class are: *adhesive films*, whether "unsupported" or supported on glass, fabric, or foil webs, and whether used by heat or solvent reactivation; *lump and powder adhesives*, which are heated and applied as a "hot-melt;" and *pastes*, solvent-free, which must of course be cured to develop cohesive strength. The epoxy resin based paste adhesives are among the most versatile adhesives available.

Equipment for Application

Equipment required in adhesives application and bonding must supply an adequate quantity of adhesive to do the job and place it where it is required, must remove the solvent, and must apply pressure and heat as required. Different types of applicators are required for different forms of adhesives, for batch or for assembly-line operation, for small or large quantities. Equipment is available which can proportion and mix a three-or-more component formula and deliver a fraction of a drop in place; yet, a large volume of adhesive is also prepared by stirring with a paddle and applying with a trowel or paint brush. Precision reverse-roll coaters and gravure coaters have been developed to apply metered thin films of adhesives to a moving web, prior to lamination. A variety of jigs, fixtures, ovens, and presses, have been developed or adapted to the drying and bonding steps of the assembly.

The Fallacy of the Purely Chemical Approach to Adhesive Selection

It has been quite common practice to specify an adhesive for a given application by chemical formula. Aircraft adhesive development brought to light a fallacy to this approach, since it showed that required physicals can be obtained with various chemical formulations. At the beginning of this development, Air Force Specification 14164 included requirements for such factors as tensile and shear strengths at −67, 75, and 180 F; bend, fatigue, and impact strengths; salt spray, water, fuel immersion, and chemical resistance; and application techniques. Definitions were based on the limited knowledge then available to the industry. These "target" specifications were given to the various adhesive manufacturers to develop formulations to meet rigid performance requirements. The various adhesive companies approached the problem from different angles, and the result was that a number of entirely different chemical compositions met the required specifications. Among these were vinyl formal phenolic, nylon phenolic, neoprene phenolic, vinyl-epoxy, acrylic-phenolic-epoxy, and butadiene-acrylonitrile-phenolic. Comparable properties were obtained with each thermo-setting resin adhesive species then known. Some of the six chemical types listed were available as liquids, some as pastes, some as powders, some as powder-liquid combinations, and some as films (both supported on glass and unsupported).

The Air Force approved an adhesive in each category, attesting to the fact that they all met specification requirements. While some might offer extra strength characteristics in one respect or another, the desired bond characteristics had been met from six different chemical directions.

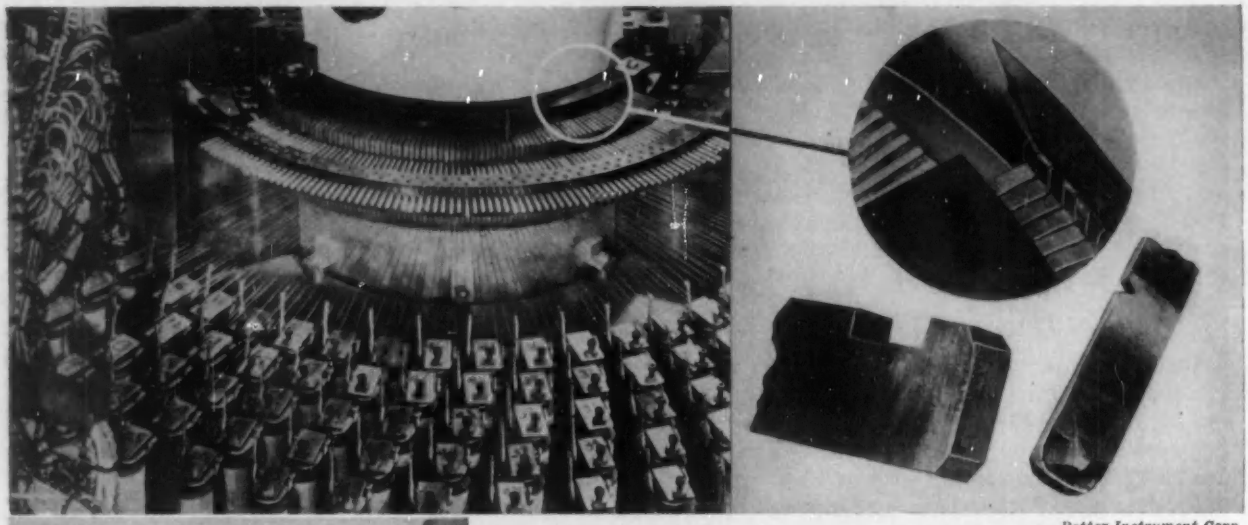
Where to Use Adhesives

The three most logical opportunities for use of adhesives in the design of a product are: (1) Where adhesives are the *only* possible solution to a fastening problem, either because of the properties of the materials to be joined, or because of special properties required of the finished assembly; (2) where adhesives are preferred for bonding because of possible cost savings in production or performance superiority, even though mechanical fasteners may be feasible; and (3) where adhesives may be used as a complement to other joining methods.

Only adhesives can normally be used in some applications—for instance, in bonding cast iron to magnesium, the bonding of the newer "rigid" plastics such as, "Kel-F," "Zytel," "Teflon," and "Plio-Tuf," the laminating of vinyl to steel sheets, the bonding of copper to phenolic laminates for printed circuit work, the bonding of wood to metal or silicone rubber to metal and the "sandwich" constructions now being adopted for an increasing number of commercial products. Also, only adhesives are suitable for bonding many heat-sensitive materials, such as thermoplastic acrylic and polystyrene sheets, whose physical properties could be seriously affected by other bonding methods.

Adhesives often solve the bonding problem when the product design makes it difficult or impossible to use mechanical fastenings, when welding or brazing of dissimilar metals would result in electrolytic corrosion, and when joining thin plastics and extremely fragile components.

Typical examples of the use of adhesives for joining, where mechanical fasteners proved unsuitable, are: "sandwich" constructions, such as those using porcelain-coated or aluminum facings and honeycomb or foamed plastic cores, typically applied as shown in Fig. 1; aluminum-to-copper fin tubing assemblies for heat exchange use, as in Fig. 2; radar wave-trap assemblies consisting of copper-to-silicone base laminates, shown in Fig. 3; glass-to-glass; and the new expanded "foams." For most of these applications, mechanical fastenings were found to seriously weaken the assembly. Such was the case in design of a helicopter rotor



Potter Instrument Corp.

Fig. 4—(Above) Electronic printer, on which the type faces and steel faces for the reciprocating anvils are bonded to magnesium shanks by adhesive. In service the reciprocating anvil strikes the steel type-face. The adhesive, an epoxy-elastomer alloy, is applied in liquid form and cured at 310 F for 20 min. The assembly was destruction tested for six hours under approximately 100,000 smashing impacts without failure of the adhesive; yet, at this point the steel facings were worn past usefulness.

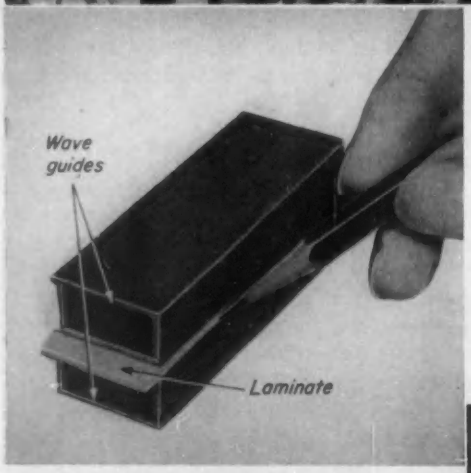
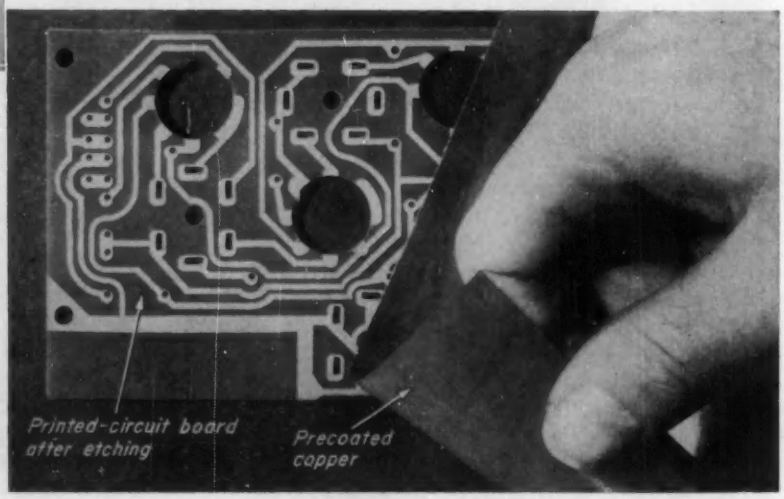


Fig. 3—Mock-up of aircraft radar assembly, consisting of two brass channel guide vanes insulated from each other by a glass reinforced silicone base laminate. An elastomer-modified thermo-setting resin-based adhesive is used and is cured 30 min. at 300 F under 100 lb per sq. in. pressure. Shear strength up to 3500 psi is obtainable with accompanying peel strength of about 19 lb. Although the adhesive in this case is brushed on, it may also be applied by roller coat, spray or other application techniques.

Fig. 5—(Below) Advances have been especially rapid in adhesive formulations for electronic printed-circuit work. The adhesive is applied by spray or roller to especially prepared electrolytic sheet copper and then molded simultaneously with phenolic-resin impregnated paper. The cure cycle is 35 min. at 335 F under 1100 psi pressure. The copper that remains after etching is firmly adhered to the base laminate.



blade. Originally adhesive-bonded in part and partly reinforced with rivets, it is now entirely bonded. The change to adhesive bonding was made because of fatigue failure which occurred at the riveted points. Other examples include the attachment of type faces on an electronic printer, shown in Fig. 4; printed circuitry, Fig. 5; and the record playback cartridge, Fig. 6.

Advantages of Adhesive Bonding

Adhesives often prove to be the best of several possible joining methods for a particular design. Advantages often resulting from use of adhesive bonding in mass production are: (1) Adhesive materials are generally less costly than other joining materials; (2) sturdier construction usually results; (3) less after-finishing is generally required than when welding, soldering, or brazing methods are employed; (4) low labor cost results since few specialized workers are required; (5) greater speed of assembly reduces production costs; (6) the design can often be simplified; and (7) lighter weight of the completed assembly results in economies in packing and shipping.

Adhesives can often be used advantageously in conjunction with other fastening or joining methods as follows: (1) For temporary positioning or holding, preliminary to

joining by other means; (2) for supplementary strength in a mechanically joined assembly; (3) for auxiliary bonding in otherwise inaccessible areas where the welding torch or arc electrode, for example, cannot reach; (4) where a combination of raw materials are used in the assembly—part of which might be welded, the other part bonded with an adhesive that utilizes the welding heat to cure the bonded assembly.

How to Select the Proper Adhesive

In adhesive selection, whether for automotive, aircraft, or other applications, there are but two basic considerations: (1) What are the desired properties of the adhesive required to do the job? (2) What method of application is most suitable?

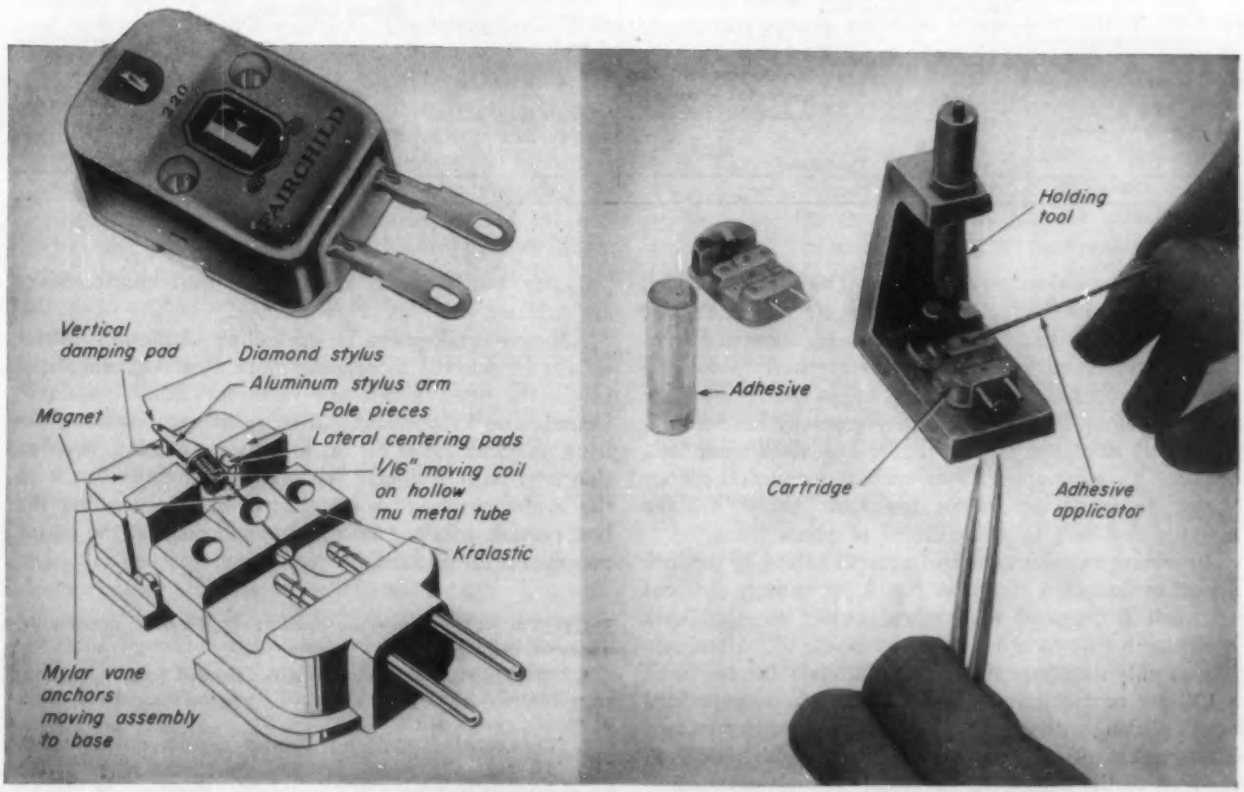
First of all, full information on the end-use properties of the completed assembly must be known. Then, within limits, it is possible to select the desired form of the adhesive—liquid, paste, powder, or film; as well as its method of application—by trowel, brush, spray, etc.; and to determine its adaptability to production scheduling, as well as heat and pressure requirements for drying and curing.

Where the behavior of the completed assembly is the major determining factor in adhesive selection, that aspect must be carefully investigated and thoroughly detailed to the adhesive manufacturer. It is not sufficiently informative to request "high strength." To the toy manufacturer, this may be 5 psi; to the camera manufacturer, 500 psi; to the designer of honeycomb structures, 5000 psi. Spell out the exact strength requirements on the specification.

Costs.—Many improper adhesive selections have been made on cost alone. Particularly since the growth of non-aircraft applications of adhesives, cost has assumed real importance; yet, as a general rule, cost goes up with increased bonding strength. Thus, the maximum strength of the bond required should determine whether cost can be reduced. The most costly adhesive may be the least "expensive" in the long run, for many applications.

Strength considerations. The type of strength required—tension, shear, peel, impact, vibration, or bend—will have a major bearing on the type of adhesive to use. If the finished assembly must withstand advanced temperatures in use, the processing method is often predetermined. Adhesives generally do not retain maximum strength at advanced temperatures when cured at room temperatures. An adhesive that cures at 100 F generally will not function properly at 400 F in constant service. However, costs in applying high-temperature cured adhesives are high, and their specification should be avoided where the extra strength that results is not required. Adhesives are in successful use where 500 F temperatures are encountered in service, such as in guided missiles, but such applications are naturally more costly.

Resistance to environmental factors. Adhesive selection also depends on whether the product must be resistant to



Fairchild Recording Instrument Co.

Fig. 6—Except for the attachment of the copper wires to the output terminals, practically all parts of this Fairchild playback cartridge are assembled with adhesive. In an assembly measuring less than one square inch are parts of Mylar film, aluminum, mu-metal, sintered iron, Alnico magnets, Kralastic, 0.001 in. copper wire, rubber, and silver plated brass, all assembled with an epoxypolyamide alloy liquid adhesive. Of particular interest is the fact that one of the adhesive changes its viscosity during production in direct ratio to the flow characteristics demanded for each operation. By the time of the final step in assembly, the adhesive has thickened to an extremely viscous paste needed to anchor the diamond stylus arm assembly prior to oven curing.

Table I—Check List of points to consider and discuss with adhesive vendors, for proper selection of adhesive material and process of application

Type of Operation	Type Adhesive Desired	Method of Application	Physical Requirements	Service Condition Requirements	Price Limitations
____Bonding	____Solvent base	____Brush	Viscosity:	Resistance to:	_____
(____to____)	____Water base	____Knife	Max._____	____Temperature	_____
____Flocking	____Mastic	____Spray	Min._____	____Solvents (which)____	_____
____Sealing	____Film	____Dip	Scale Used_____	____Chemicals (which)____	
____Coating	____Liquid	____Roller	Drying Time:	____Sunlight or Fadometer hours____	Present Adhesive Products Used (Submit samples, if possible).
____one surface	____Paste	____Extrusion	Max._____	____Abrasion	_____
____two surfaces	____Powder	____Other	Preferred_____	____Water	_____
____Impregnating	____No preference	____No preference		Bond Strength _____	_____
____Other			Drying Temp:	Aging_____	_____
Materials to which the adhesive is to be applied.	Reason for selection:	Maximum Vulcanizing Conditions available:	Max._____	Color of Film_____	_____
_____	_____	Time_____	Preferred_____	Flexibility_____	
(Give full description and submit samples to vendor, if possible.)	_____	Temp_____	Required Tack Time:	Toxicity_____	Why unsatisfactory?
_____	_____	Pressure_____	Max._____	Stability_____	_____
_____	_____		Min._____	Odor_____	_____
_____	_____	Is equipment for desired application currently available?	Pot Life Required:	Storage Conditions_____	_____
_____	_____	_____	_____	_____	Estimated Monthly Volume
_____	_____			Government or other specifications_____	_____
_____	_____			_____	

sunlight, abrasion, water, or solvents. The adhesives which are satisfactorily for paint rollers, where a requirement exists that they stand up under constant immersion in many combinations of solvents, generally have inadequate electrical properties to permit their use in the manufacture of electrical equipment. Also, they generally have insufficient heat resistance to pass the boiling alkali-water tests required for some applications, such as for use on sponge mops. In specifying solvent resistance, always list the solvents that will be encountered in product use.

In joining an aluminum fin to copper tubing to produce a heat exchanger, a shown in Fig. 2, an entirely different approach is required than when joining an aluminum honeycomb core to a flat sheet, as in Fig. 1. Aluminum honeycomb structures are most effectively bonded with a 100 per cent reactive adhesive in film form, supported on glass, along with a sprayable liquid adhesive as a primer. These adhesives are thermo-setting to give high strength required of the completed assembly. The aluminum fins, however, are best bonded with a low viscosity, readily flowable, high solids paste. Such an adhesive is supplied in self-curing or low-temperature curing formulations. Whether either of these adhesives contain substantial amounts of epoxies or some other types of resins, should be of no consequence provided the required physical characteristics are obtained.

Adhesive catalogs can be misleading. Adhesives cannot usually be selected successfully from a catalog. Localized conditions often necessitate variations from "standard" formulations to more fully meet specific production problems. A check list of factors to consider in adhesive selection is given in Table I. Discussion of these factors with the manufacturers of adhesives will help in securing the best possible adhesive for a given application at the lowest overall cost for material and application.

EDITOR'S NOTE—Previous *Product Engineering* articles on adhesives include:

1. "Criteria For Designing Adhesive Bonded Joints", Oct '53, page 144, which describes a method for calculating the strength of metal-to-metal joints.
2. "Pre-Coated Copper for Printed Circuit Manufacture", May '54, page 193, which describes the process of preparing printed-circuit boards.
3. "Metal-to-Metal Bonding With Epoxy Resin-Based Adhesives", July '54, page 166, which gives some design factors on use of epoxy-based adhesives primarily for aircraft applications. Included is a table giving typical mechanical strengths of epoxy resin bonds, after first bonding and after subjection to environmental tests.

Pilot Control Devices

Can be manually or automatically actuated to control motors or other power units in a predetermined sequence of complex operations; also provide protection of machines and safety of operating personnel.

G. W. HEUMANN
Industry Control Dept., General Electric Co.

MODERN PRODUCTION MACHINERY usually incorporates several motors in a single machine. The operation of these motors is necessarily interconnected and may also be interlocked to the starting and stopping of motors affecting the automatic transfer of material to, from, or between machines. Manual control of the primary-power circuits which energize these motors is not feasible for several reasons. First, there is danger of injury to operating personnel if switches are actuated during periods of high overcurrent such as might occur during heavy overloads, accidental stalling, or short circuits. Second, the machines can be damaged through faulty operator judgment. Third, production speed is limited to the capabilities of the individual operator. Fourth, rapid and complex interlocking and sequencing of motors and other power operators is generally beyond practical human capabilities.

Advantages

To solve these problems pilot-control devices—push-buttons, master switches, limit switches, electrical interlocks, process-actuated switches, and relays—are used. These devices are basically switches, manually or automatically operated, which are used to operate the magnetic controllers connecting and disconnecting the primary-power circuits of the motors. The advantages of pilot-actuated electromagnetic control are several:

1. Flexible control of as much as several hundred horsepower by pilot-control devices requiring less than an ounce operating pressure and relays requiring a few milliwatts to energize.

2. Greater safety to operating personnel, since the pilot-control devices can be located at a distance from the heavy-current contactors. In the case of hazardous machine operations the operator can be located some distance from the machine.

3. Increased protection of machines against mechanical damage, because pilot-control devices provide a means of protecting against excessive torque demands or excessive motion in any direction. Also, two or more machines can be interconnected so that failure of one will automatically remove power from others likely to cause additional damage.

4. More flexibility in control layout and installation. The magnetic power controller can be remotely located, whereas the pilot devices for actuating the magnetic controllers can be mounted in locations most suitable for machine operation.

5. Greater convenience to the operator, and more reliable operation of the equipment, since the operator and pilot devices can be installed in a location from which he can best observe the operation of the machine.

6. Increased facility for automatic machine operation. Power controlling and switching devices may be sequenced, interlocked, or actuated automatically by devices corresponding to various mechanical motions or electrical functions. Possibility of multiple-machine sequential control is expanded.

Principal Types

Pilot-control devices used for high-production machinery and automatic control operations are:

Push buttons—used by operator to initiate control action by hand.

Master switches—perform the same function as push-buttons, except that they are generally turned instead of pressed. Because of increased complexity of machine design they provide greater flexibility in circuit arrangements.

Electrical interlocks and relays—are interconnected to

obtain automatic control actions or perform protective functions.

Limit switches—actuated by travel of machine parts or by the work. They can automatically start and stop machine movement or provide signalling or circuit-interlocking functions.

Process-actuated switches—devices responsive to pressure, flow, velocity, etc., which are used to initiate control action automatically.

PUSH BUTTONS. Push buttons are among the most widely used pilot-control devices. They consist of a contact unit, shown in Fig. 1(A), and a push button or other manual actuator. In the majority of cases push buttons have a spring action and, unlike toggle or similar switches, when the finger is removed from the button the contacts automatically return to their unoperated position. In the cutaway view shown in Fig. 1(A) bridge-type contacts, which provide two breaks in series, are supported in a housing molded of arc-resistant compound. This also serves as a guide and support for the moving parts, stationary contracts, and terminals. The unit shown has two contacts which are actuated by pressure on the plunger. When this member is depressed the lower or normally-open contact is closed, and the upper or normally-closed contact is opened. When pressure is released the plunger returns to its original position.

A completely assembled push-button switch showing both contact unit and push-button actuator is shown in Fig. 1(B). This particular unit requires only a single hole for flush mounting in a panel. It can be made oil-tight by use of suitable gasketing. Such units are used on machine tools and other production machinery to prevent oil or coolant from seeping inside the switch and causing contact deterioration.

To provide flexibility in control-circuit arrangement, contact units can be obtained with a variety of actuators. For example, to avoid accidental operation a mechanical locking attachment can be provided to prevent closing of the back contact unless the lock is turned. Other type turn-button actuators hold the button in either operated or unoperated position. Two single-button units may be latched together by a toggle-type mechanism so that contacts are maintained in operated or unoperated position if either button is pressed. Mushroom heads, long buttons, combination long and turn buttons, and key locks are other examples of actuators. To provide convenient indication of machine-operating conditions, push-button indicating-light units which match the push buttons in appearance and mounting dimensions are also available.

Push-button units may be assembled into a push-button station which is suitable for mounting on a flat surface, a bracket, or similar suitable support. An example is given in Fig. 2 which shows the front of a grinder with push-button units mounted in the cover plate over a cavity in the machine frame. Control wiring is carried entirely within the machine. The control wiring is brought to the control station inside rigid conduit.

Use of a pendant station supported by a steel cable and connected by wiring through a flexible conduit is another method of installing push buttons. Such stations may be moved about through a limited area. This type of pendant station is widely used on floor-operated cranes.

MASTER SWITCHES. These switches are multicontact, multiposition manually-operated devices. The contacts, of the sustained type, are generally actuated by rotation of a control shaft bearing cams. By suitable design of the cams varied contact closing and opening sequences can be obtained for the several switch positions.

There are two major fields of application for master switches. First, they are used for setting up circuits to select various modes of operation of complex machinery. This selection is effected without actually controlling the operation. A typical application is seen in Fig. 3, which shows the operators' control panels of a sheet mill. The master switches, indicated by arrows, are mounted in the doors of the control cabinets. A second application is

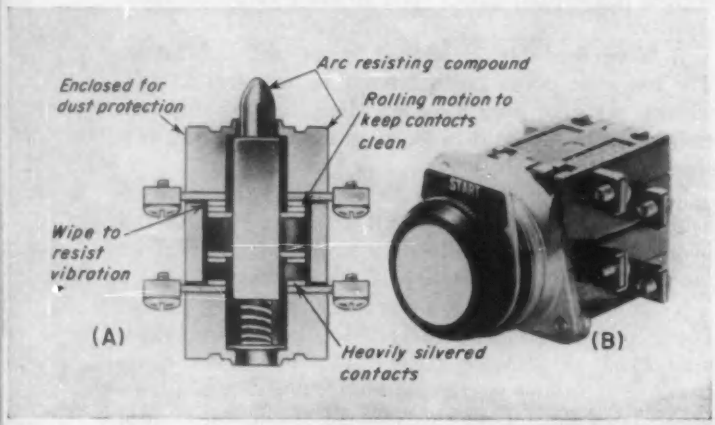


Fig. 1 — Push-button contact unit and actuator. (A) Cutaway view of contact unit showing bridge-type contacts supported in housing molded of arc-resistant compound. (B) Assembled push-button unit showing push-button actuator combined with contact assembly.

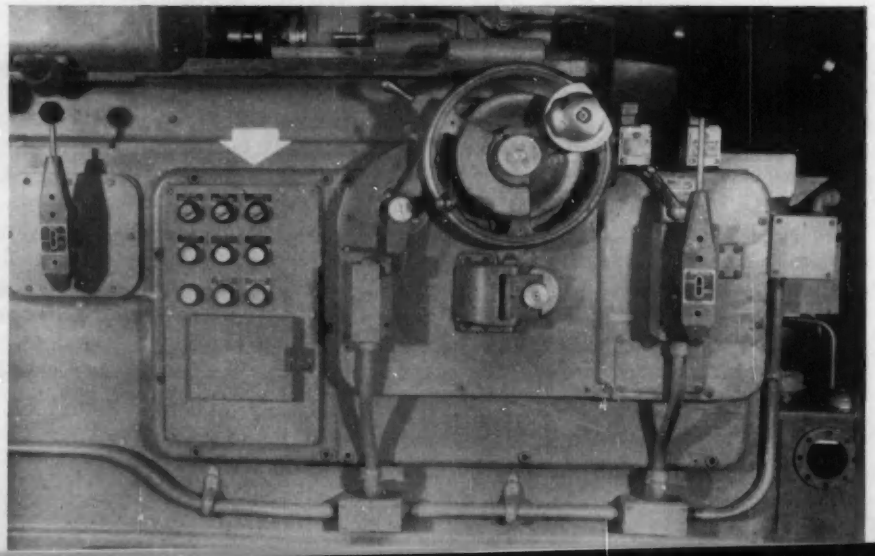


Fig. 2—Push-button units assembled and mounted on station on front of grinder.

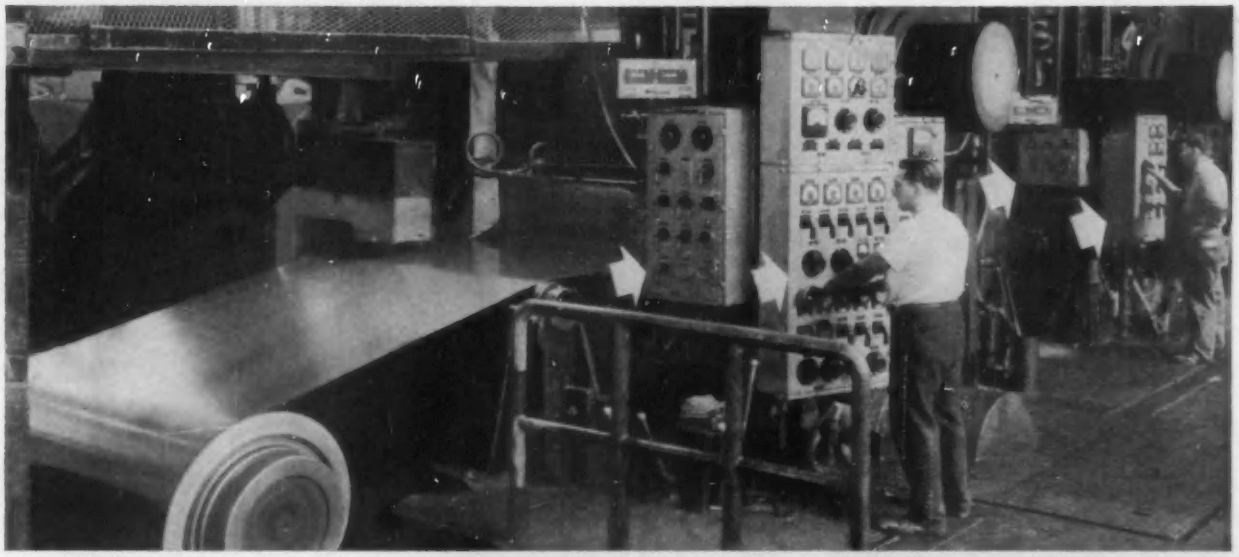


Fig. 3—Sheet mill showing master switches, indicated by arrows, mounted in doors of control cabinets and actuated by pistol-grid handles.

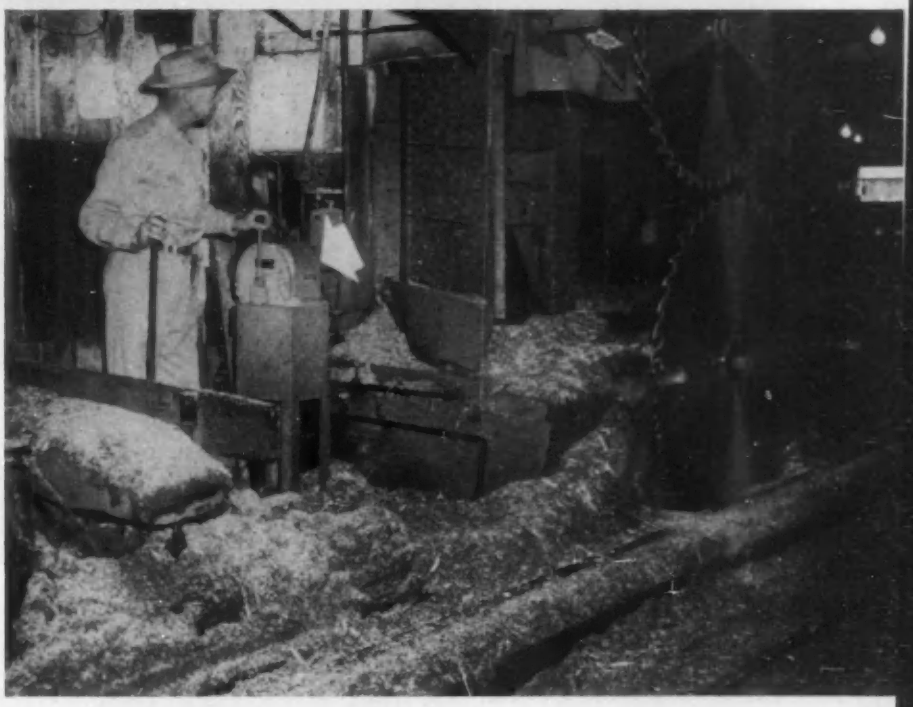


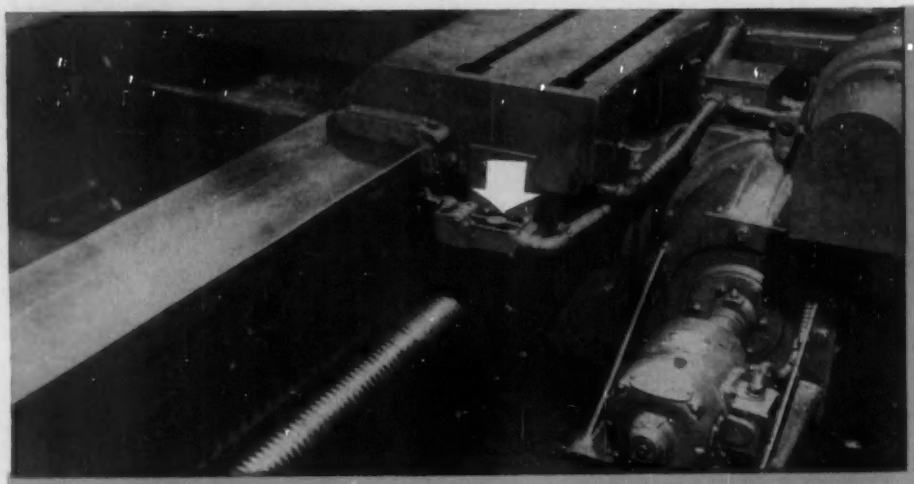
Fig. 4—Ball-and-rod type master switch, indicated by arrow, used for controlling direction and speed of carriage which feeds logs into circular saws.

manual control of both direction-of-rotation and speed of motors driving heavy machinery, Fig. 4 shows an example of an installation in a lumber mill. Using a ball-and-rod type handle, the operator moves the switch into various positions, thereby controlling the direction and speed of the carriage which feeds logs into a circular saw. Similar switches are used on cranes, mine hoists, mill auxiliaries, and similar heavy-duty equipments.

LIMIT SWITCHES. Limit switches are mechanically actuated by the movement of machine parts. They are principally used to automatically stop machines at the ends of travel, but are often applied where a machine-actuated contact is needed to give a control impulse. Typical jobs performed by limit switches are (a) machine interlocking—preventing machine movement if there is danger of interference with other parts; (b) safety interlocking—preventing machine operation if a safety guard is not in place; and (c) actuating—initiation of a motion if some other motion has arrived at a certain position in its travel.

Two basic types of limit switches are the track-type and geared units. The track-type are directly actuated by the moving machine part such as a cam, dog, etc. A typical track-type switch is shown on the right in Fig. 5. It consists of an enclosed contact assembly and an actuating lever. The actuator is a roller lever. A variety of contact arrangements are available, as well as a choice of actuators, such as forked levers and push rods. Contact ratings are not standardized, and manufacturers' handbooks should be consulted for data on contact making, carrying, and breaking ability. A typical installation of the track-type switch on the bed structure of a lathe, is shown on the left in Fig. 5. The saddle cross slide actuates the switch lever at one end of its travel and prevents it from running into the face plate.

Geared limit switches are connected by gears or chains to the motor shaft or some other shaft on the driven machine. A typical switch of this type is shown on the left in Fig. 6. The switch shaft, connected to a worm, turns a set of cams through a train of gears. The cams actuate enclosed contact units at the top and the right



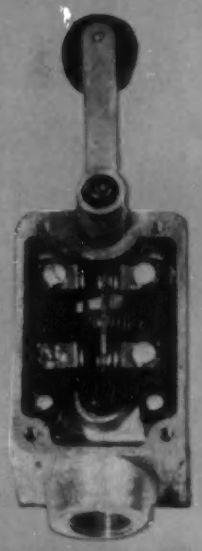
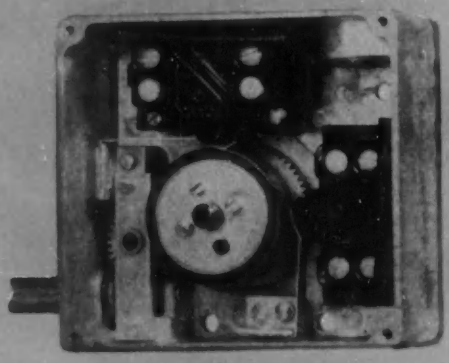


Fig. 5—Track-type limit switch, at right; and installation on bed structure of lathe, above.



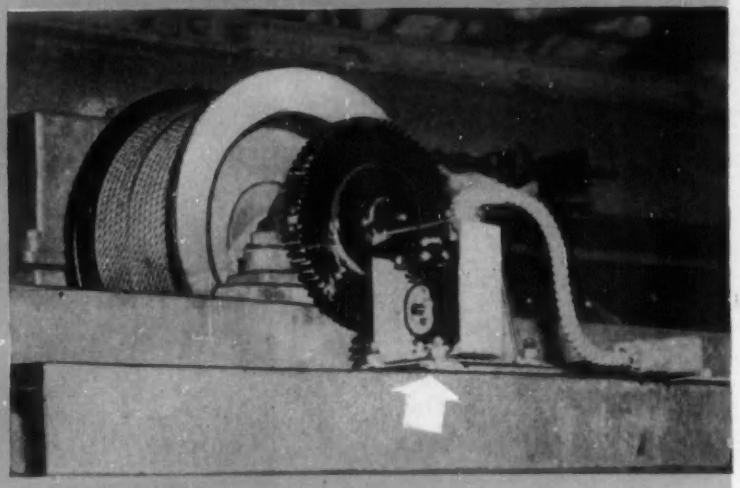


Fig. 6—Geared limit switch, at left; At right, typical installation on small industrial hoist. Used to stop hoist at end of up and down travel.

side of the switch box. Contact operation is adjusted by turning the cams on the shaft. Fig. 6 also shows a switch of this type connected to a small industrial hoist. It is used here for stopping the hoist at the ends of the up and down travel.

When a track-type switch is actuated by a cam, the impact on the switch parts causes stress which, if excessive, result in damage to the switch. For this reason there are limitations to the speed with which the shaft of geared limit switches may be turned. Speed limitations vary with different designs of limit switches, and manufacturers' recommendations should be obtained.

PROCESS-ACTUATED SWITCHES. It is often desired to automatically obtain a control impulse as a function of some quantity of a process being controlled. For instance, an air compressor is started when the pressure in an air system drops below a desired value; the compressor is stopped when the pressure is built up again. A pressure switch as shown in Fig. 7 may be used as a pilot-control device. It contains a diaphragm which forms one wall of a pressure chamber. The other side of the chamber is piped to the system pressure which is to be controlled. The diaphragm is mechanically connected to a compression spring which can be adjusted so that its force on the diaphragm balances the force exerted by the system pressure. If the system pressure is above or below spring pressure, the diaphragm deflects and opens or closes a contact. Such switches can be obtained for contact operation between 1 and 5000 psi. Similar switches with a large diaphragm and weak spring are available as vacuum switches for a range between 3 and 28 inches of mercury.

Float switches are used to start and stop motors automatically as a function of liquid level in a stand pipe or storage tank. Other switches respond to temperature.

RELAYS AND ELECTRICAL INTERLOCKS. Relays are magnetically actuated devices suitable for remote operation of control circuits. A typical control relay is shown in Fig. 8(A). Relays are actuated by voltage or current in an

electric circuit. Overload relays shut down the motor when it is in danger of damage due to current overload. Current and voltage relays are magnetic relays set to respond to a set value of current or voltage. Phase-failure or phase-reversal relays disconnect the control circuit on a polyphase system if one phase is interrupted or phase sequence is reversed.

Control relays are used primarily as contact multipliers. For example, it may be desirable to actuate several motors, to interlock other circuits, and to operate signals. Pilot control devices are not equipped with multiple contact structures, so the pilot device actuates a relay and the several relay contacts energize and deenergize the required control and signaling circuits.

Various combinations of normally open and normally closed contacts are available with control relays. Contact capacity of such relays is comparable to that of heavy duty push buttons. Relays can be obtained with fixed contacts which cannot be changed at the installation without the use of additional parts; or they can have reversible contacts which can be changed by reassembling present parts, using conventional tools. Universal contacts are obtainable so that upon installation each may be connected as a normally-open or a normally-closed contact. Which contact type should be specified depends on the degree of operational and installation flexibility desired.

CONTACTOR INTERLOCKS. Contactors are used primarily for switching primary power circuits, but are often equipped with electrical interlocks or auxiliary contacts of lower current rating than the main power contacts. Fig. 8 (B) shows an a-c lift-type contactor with an electrical interlock on the side. Current rating of the interlocks is equivalent to that of relay contacts. Interlocks may be normally open or normally closed. Because of limitations in contactor size and in magnet force, the number of interlocks is limited to two on the smaller lift-type contactors; more interlocks may be obtained on the larger.

Proper selection of pilot contact devices requires a knowledge of operating voltages and current ratings. Motors and solenoids are connected to the incoming line voltage which may be 220 but usually is 440 volts. Control circuits are often connected to a 110-volt supply for reasons of operator safety and reliability.

There are no nationally recognized standards on current ratings of pilot circuit devices, but individual manufacturers establish current ratings for their equipment. As an example Table I lists the current ratings of a typical line of standard and heavy duty push buttons. These two classes indicate relative current-carrying capacity upon closing or opening an electrical circuit.

In Table I the "Make" current represents the maximum inrush current of an a-c magnet coil energized by closing the contacts of the push button. The "Interrupting" rating represents the maximum current which the switch can carry or interrupt frequently with good contact life.

Table I—Ampere Current Ratings of a Typical Line of Push Buttons

	Make (all voltages)	Continuous	Interrupting Rating						
			D-C Inductive Load			A-C Inductive Load			
			Volts			Volts			
			115	230	550	110	220	440	550
Standard Duty	30	10	1.1	0.6	0.2	30	20	7.5	6
Heavy Duty	60	10	2.2	1.1	0.4	50	30	8	6

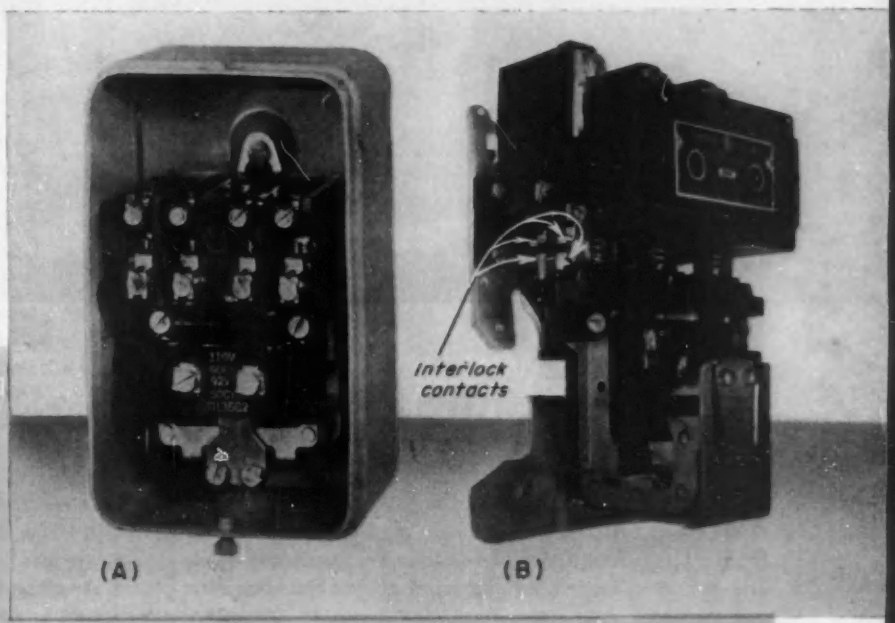


Fig. 8—(A) A typical power-control relay. (B) A-c lift-type primary power contactor with an electrical interlock.

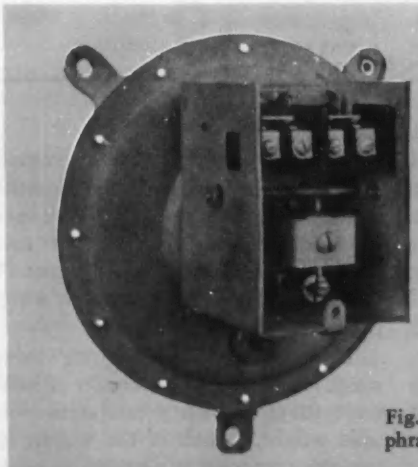
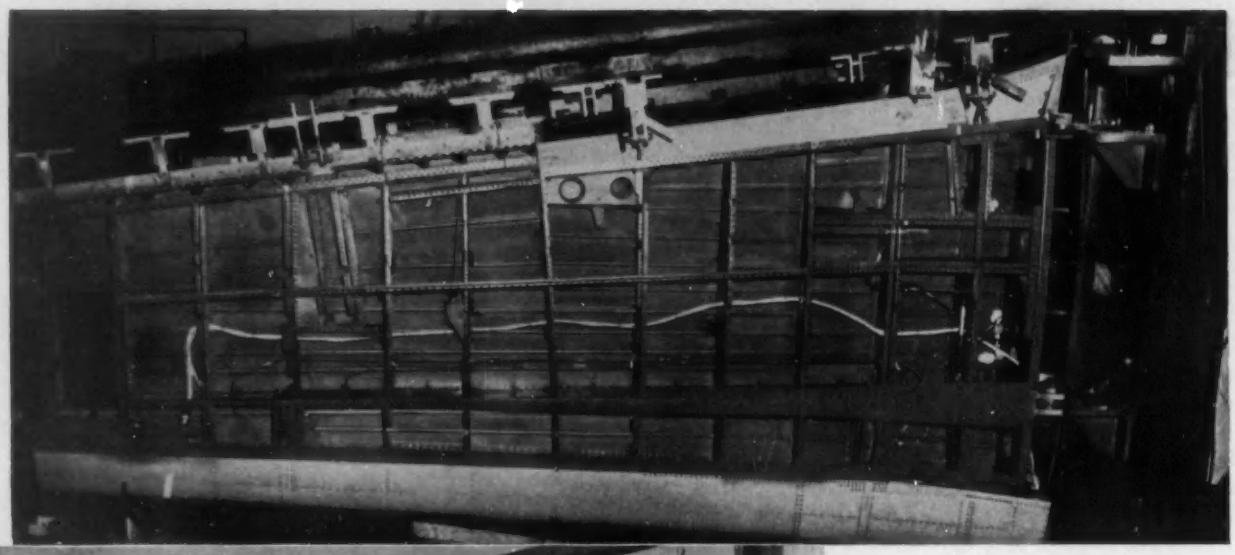
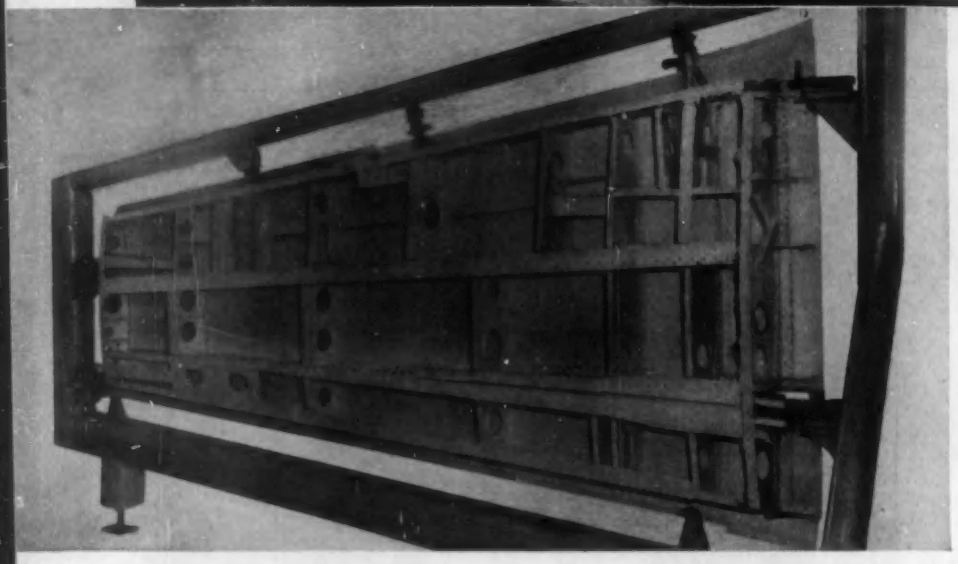


Fig. 7—Pressure switch used to obtain a control impulse when diaphragm is deflected by air pressure above or below a spring pressure.





TOP VIEW SHOWS the conventional aluminum alloy wing section of an F9F, representing the typical sheet stringer construction. Below is East Coast's magnesium version of the same wing. About half of the spanwise stringers and ribs were eliminated. Skin thickness of the aluminum wing is 0.064, with 0.188 skins being used on the magnesium alloy version. Weight is the same, but torsional rigidity of the magnesium wing is 33 per cent better than the aluminum version. Using the magnesium wing on a conventional F-80 gave an increase of 5 knots in top speed. This was traced to the smoother aerodynamic shape and lack of buckling.

All-Magnesium Plane Ready for Test Flight

Soon to be announced will be the first flight of an experimental airplane, an F-80C, the airframe of which is almost 100 per cent magnesium. Located at the Mitchell Air Force Base, Long Island, N. Y., the plane is structurally complete and needs only the engine.

There are a number of advantages to using magnesium, according to East Coast Aeronautics, the plane's manufacturer, and they all add up to much simplified airframe structures and design techniques, increased strength, and greatly reduced cost. In fact, East Coast claims that they can build three planes out of magnesium for the price of two aluminum planes. A comparison of an aluminum and magnesium wing is shown here to point up the lack of ribs and stringers in the magnesium wing. East Coast claims that an aluminum wing contains about 1,650 pieces and 42,500 fasteners as compared to the magnesium wing with 500 pieces and 16,000 fasteners.

One of the big advantages with magnesium is that its thick-skinned design reduces many of the internal stiffeners, thus increasing by 42 per cent the volume available for fuel tanks, besides an increase in the plane's operating range. Previously, only wingtip tanks could be carried.

The difficulty in designing most wings stems from the necessity of sufficient strength with a minimum possible weight. Much of the weight in any plane is found in parts where compressive buckling is a critical condi-

tion. In order to increase the allowable compressive stresses, thick cross sections must be used, and here magnesium can be used to advantage with no increase in weight. Also, a thick magnesium skin is used in the final wing design. The heaviest skin gage used on the original F-80C aluminum wing was 0.051. The magnesium wing used skin from 0.064 to 0.375.

Tests of bending loads on the aluminum wing showed that 66 per cent was distributed to the spar caps, and 34 per cent in the skin and stiffeners. The magnesium wing reverses this, putting 66 per cent of the load on the sheet skin alone, since it does not have stiffeners. Under static tests, the magnesium wing did not buckle until well above flight operating loads, and torsional rigidity was increased by 50 per cent. Also, with the thick skin used, no dimpling was necessary, since it was possible to use machine counter-sinking.

In the fuselage too, there was a reduction in the number of frames, and the longitudinal stringers were completely eliminated. According to East Coast, much has been learned about magnesium with their work on the F-80C and the F9F models. But to take advantage of the light weight and good qualities of magnesium as an aircraft material, the plane should be designed from the bottom up for magnesium, rather than duplicating plans for aluminum planes where the weight had to remain the same.

How To Find What's New in Your Field

About a year ago a company called Documentation, Inc. in Washington, D. C., announced a new type indexing system for companies that have difficulty keeping track of information, prints, calculations, and other data buried in their files. The new system was called Uniterm and could be handled manually (for library indexes) or mechanically for a big operation. The system made use of simple numbers, and apparently required little effort to understand and operate. Using this system, Documentation, Inc. has just evolved a publishing venture (to be described later) which is startlingly unique.

With Uniterm, when an article on, say High Strength Alloy Steel Powder Metal Parts is referred to the library, it is stamped with the next number up. The number has no meaning other than for identification. Say the number is 798. The librarian next goes through the article picking out any and all subject headings like: steel powder production requirements; gear design; comparison with solid steel gears; mechanical properties of steel powder metal parts, and so on.

Then, using 3 x 5 in. cards, a card is made out for each of the above headings. These cards have ten columns (0 to 9). Under column 8 (because the number of the article 798 ends in 8) on each of the cards containing the subject headings the number 798 is inserted. As each article is received by the library the process is repeated. As the files build up, many of these same cards will be used to identify other articles on the same or similar subjects, perhaps with additional data.

Now, if an engineer wants to find something, say, on gear design with steel powders, he does not have to know the article title. By looking up the two cards under the subject headings: gear design; and steel powders, he looks to see if any number appears on both. The number 798 does, indicating that this, then, is the article desired. Another number might appear on both cards, indicating another article on the subject.

Dr. Mortimer Taube, president of Documentation, Inc. feels that with the Uniterm system, every term is a filing term, and all the "see" and "see also" references can be eliminated. In one case, he claims that two librarians were able to do the work of six, and all the headings were reduced from 78,000 to 3,000.

So much for the system. It caught on, and many large companies have engaged Documentation, Inc. to set up the system in their libraries.

From here Documentation Inc. branched out, and using this Uniterm system, they set up Information for Industry, Inc. (IFI), a company which publishes a list of all chemical patents issued by the U. S. Patent Office starting with Jan. 1, 1955. About 6,000 patents are issued a year, which makes it difficult for companies to keep abreast of the latest patents taken out in their field.

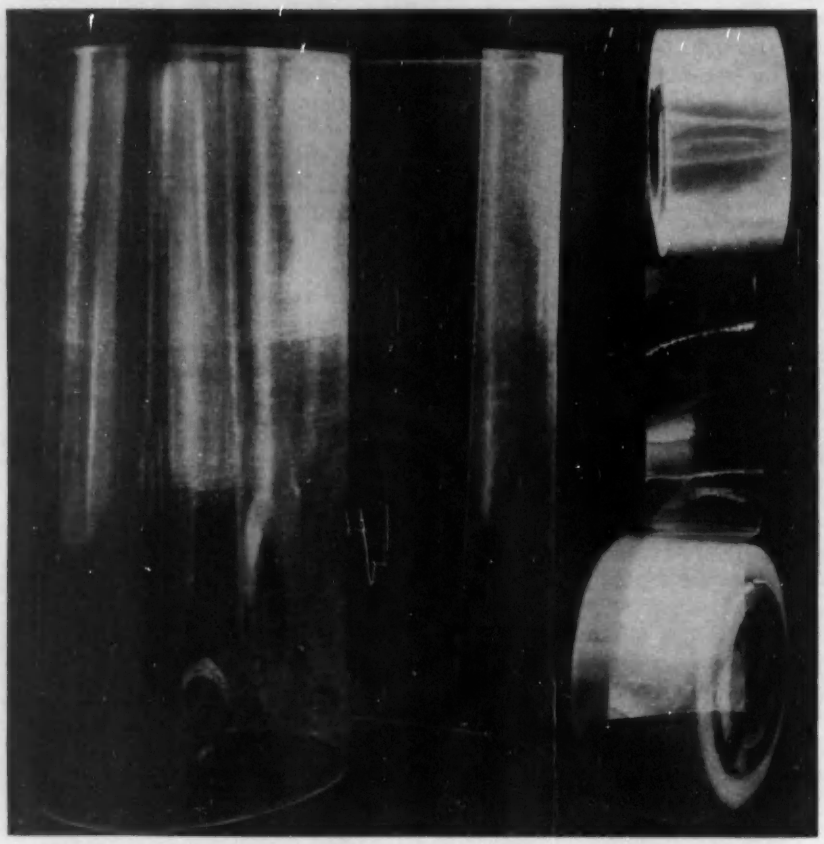
Skilled chemists at IFI analyze each full patent to point out the products, chemical families, applications, intermediates in a synthesis, solvents in a reaction, catalysts, apparatus used, assignees, and inventors. Also, the classification assigned by the Patent Office for each patent is included in the Uniterm index. The index is keyed to the chemical patent excerpts contained in the official Patent Gazette.

The Uniterm Index is issued six times a year to subscribers, and each issue is cumulative—covering the patents issued during the immediate previous two months, and all preceding months to Jan. 1955. Therefore, it is not necessary to search volumes of indexes, nor does the volume double in size as the second issue is added. With the card index, numbers are added to the cards under already established headings; other headings are added, when necessary.

The index comes in a bound volume about the size of *Product Engineering*. A second volume of the same size contains excerpts of the patents referred to in the index. IFI feels that the complete patent need not be shown, for the company using the volume is interested only in finding out the developments in some particular phase on which they too, might be working, or which might give them ideas for future plans. If the excerpts show this, the company can write to the Patent Office for a copy of the patent.

Subscription for such a service is $1,000 per year. One requirement: as each issue is received, the subscriber must return the earlier, outdated issue. IFI feels that the big advantage to such a service is that in about five years the subscriber has a volume with a complete listing of all the patents issued since Jan. 1955, with the size of the last volume not too much larger than the first.

Information for Industry has set up this system just for the chemical industry, but expects to apply it to the electronics field soon, and others later.



CLEAR NYLON 8200 FILM. In thin gages, it can be used for packaging. In its unoriented form, it can be used as a laminate with vinyls and other materials, giving an abrasion resistant surface. In such a form its possible use is for conveyors. Another feature is better modability for larger parts with thicker sections.

A New Nylon

Compounded from a material called caprolactam and called nylon type 6, this new type of nylon was just announced by the Barrett Div. of the Allied Chemical & Dye Corp. with the claim that it will open up a range of new applications for nylon in industrial and consumer products. High strength nylon sheet and film, bottles, and large and intricate shapes, extruded and molded were some of the products predicted.

As Barrett engineers see it, nylons as a class are too solid to extrude or injection mold below some temperatures. Above the lowest workable temperature they rapidly become fluid. Plaskon Nylon 8200, as the new nylon is called, has a relatively high molten viscosity, and is adapted to blow-molding. Molding 8200 at a low mold temperature gives it maximum impact strength or toughness with minimum mold shrinkage. As the mold temperature increases, 8200 becomes rigid. At 200 F it is still not brittle. This characteristic is caused by the controlled crystalline structure which permits the molder to vary the finished product's physical properties in thin sections.

Also, 8200 does not decompose or liberate gas during the molding or extrusion cycle, permitting very thick sections or very large pieces to be molded with a minimum of voids caused by trapped air or gases. Parts molded from 8200 in natural color are opaque white, but can be cold-colored after molding.

Because the new nylon can be extruded easily and has the controllable crystalline structure, it can be formed into a clear film with high strength, toughness, abrasion resistance and heat resistance.

Some of the properties are: Yield point, 8,500 psi; Ultimate Tensile Strength, 12,000 psi; Ultimate elongation, 300 per cent; Modulus of elasticity in tension, 300,000 psi; Compressive failure, 11,000 psi; Flexural strength, 10,000 psi (did not break); Heat distortion temp., 136 F; Flow temp., 419 F; Coefficient of Linear Thermal Expansion/deg. F, 4.6×10^{-5}.

Some suggested applications of the new nylon have been: gears, bearings, bushings, wire jacketing and cable coating, valves, instrument housings, and coil forms.

The Electronic Supervisor For Remote Plant Control

IBM's new "electronic supervisor" the company's latest addition to the automation field, is a central control system that follows preset programs and automatically switches on or off up to 40 groups of remote operations, lights, motors, values—each on its own time schedule. Using carrier current signals and operating on existing electrical circuits, the system does not require the installation of a single transmission wire. The units covered by the system may be scattered over many acres.

By superimposing electronic pulses of from 2,106 to 19,000 cycles on the plant's electrical distribution system, the same lines that provide the 60 cycle current for operation of the devices can be used to transmit remote control signals like start and stop. These commands will originate from a central operations panel, and can be programmed automatically on a schedule. Also, time recording and time indicating equipment including wall clocks, may be automatically synchronized with a radio controlled master clock supervised by the National Bureau of Standards radio time signals.

The system can transmit and execute 40 ON and 40 OFF commands by using only four carrier frequencies. An encoding device is used at the central control, and an electro-mechanical decoder at remote location which responds only to coded pulses of the proper frequency. When a signal of the correct frequency is detected, it is amplified and applied to a cold cathode tube which "fires", and closes the desired circuit. The basic receiver requires only 5 electronic components; two capacitors, two coils, and a cold cathode tube.

National Science Foundation Criticized

Outspoken Rep. Albert Thomas (Dem., Texas) was pulling no punches at a recent subcommittee meeting when he charged the National Science Foundation (NSF) and its director, Dr. Allan T. Waterman with using its $11-million of Federal grants for the support of science to warp university programs and projects to the pattern set in Washington.

Rep. Thomas is chairman of the subcommittee which recommends appropriations for such independent agencies as the NSF. While fund recommendations of a subcommittee chairman may be overridden by the full committee, or by the full house, it is rather difficult to do. Consequently, some people are not too optimistic about the proposed expansion of NSF activities, which asked $18.2-million for the coming year. NSF splits this money among schools in most of the 48 states for research projects, for financing graduate work by hundreds of students in needed science field, and to finance a review of these programs by boards of scientists.

The power of these boards to approve or disapprove a University's performance under an NSF grant is the point which brought Rep. Thomas up in arms. Thomas described these board members—who get a per diem payment when on NSF business—as "agents" through which a Washington agency with money to grant or withhold might eventually dominate the science programs of our colleges.

Here is the tenor of some of Rep. Thomas' charges: "It is not going to be very long before you have a charge thrown in your face, and you are going to have a hard time denying it, that the National Science Foundation is trying to take over in this country the colleges and the universities, and lay down the pattern and control, through a federal bureau in Washington, the education and training of college students and scientist. . . . It is what you lay down. You offer this bait to the colleges and universities: 'If you want this money, you take it through this channel. We are the mastermind. This is what we want you do do.' Is that correct? . . . These are agents (referring to scientists brought in to aid in the discussion) of the Foundation. Call them whatever you want to, consultants, friends, or paid employees. They are doing your work, acting by virtue of your authority. So it comes right back to the question I raised, they are doing the work and at your bidding. If they do not like it, out the window it goes."

Dr. Waterman's reply to this last remark was: "It is like an expert witness in court. He is called in because he is an expert, and not to prejudice the case."

To which Mr. Thomas replied: "I have never heard of anyone calling in an expert witness unless they were to pay him, and unless he was to testify favorably to those calling him."

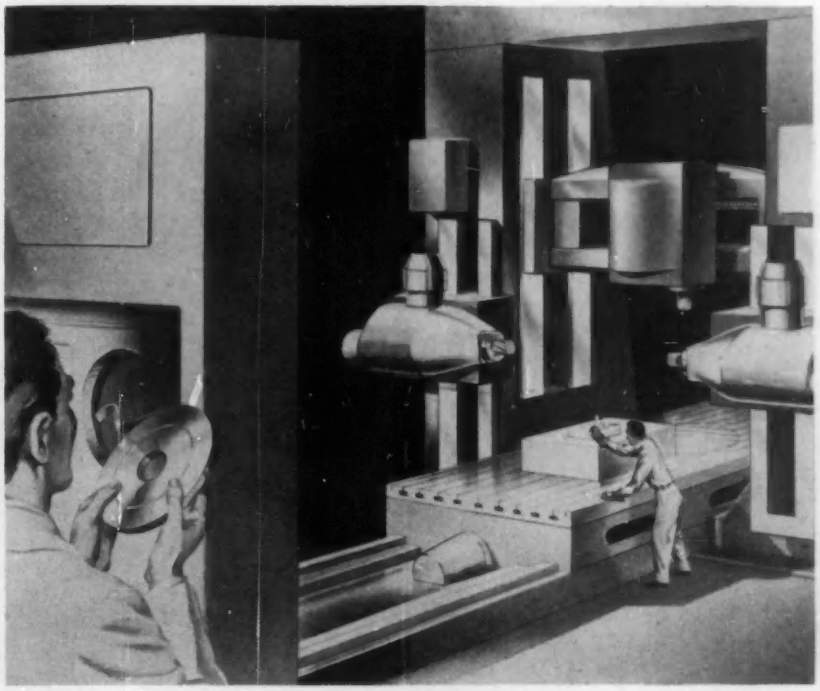
Tape Controlled Milling Machine

An artist's conception of the aircraft industry's first electronically controlled milling machine. A 200-ton unit, it will be developed by Convair Div. of General Dynamics Corp. under a $1,128,000 Air Force contract, and along with its electronic system, will be completed in about 18 months.

The machine's electronic system will get its commands from data fed into a computer. These commands are then transcribed to punched tape. The tape is then fed into the electronic director, where the information is transferred to magnetic tape. This director may be used to operate the machine, or, the magnetic tape the director produces can be put into a console that electronically operates the machine dimensionally. The latter choice permits the computer-director to be used to solve problems with other types of machines—rolling mills, presses and special purpose profilers.

Convair claims that the milling machine differs from other existing machines in that it will be able to make 18 selective motions. The machine will have a 20 ft. bed with a 10 ft. clearance; a rotary turntable; two vertical cutting heads, which may be operated at once; and two horizontal cutting heads, which may be operated together. The machine will produce wing spars, milled skins, contoured forged bulkheads, and will sink dies.

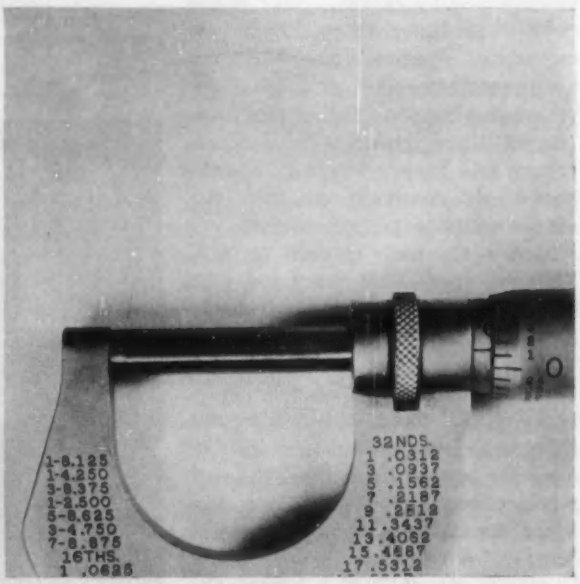
Convair feels that the new machine will greatly reduce tool engineering lead time, make possible savings in materials, and give a "built-in" quality control which will eliminate intermediate inspection points.



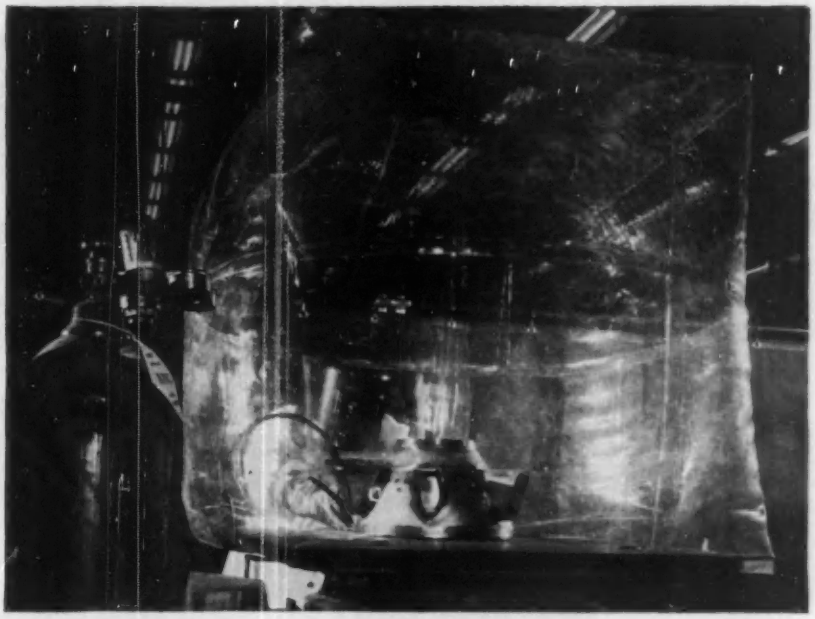
THE NEWS IN PICTURES

THE DESTRUCTIVE EFFECT OF RAIN is just one of the problems faced by designers of supersonic aircraft. Shown here are specimens which have been fired through 500 ft. of rain at speeds of 1520 mph. Note damage of dumdum head at left and two specimens at far right. At transonic and supersonic speeds, rain erosion of aircraft might prove to be the limiting factor in all-weather flying. To determine the best materials for missiles and aircraft, the Convair Div. of General Dynamics Corp. tests specimens under controlled rain conditions at speeds up to 1,900 mph, about mach 2.5. The specimens are mounted in the nose of a modified 20 mm projectile, and fired horizontally through the simulated rainfall. About $\frac{1}{4}$ sec. after firing, a charge ignites and expels the test specimen and parachute. Opening loads on the 6-in vented canopy nylon parachute are 500 lb. This load checks the velocity, and both parachute and specimen land about 1,500 ft. away. Speed can be varied from mach 1.0 to mach 2.5 by controlling the main powder charge. Two types of projectiles—rounded heads, and dumdum of metal, plastic, or ceramics—are tested.

LOOKING MORE LIKE A CHILD'S TOP than the sound-wave washing machine that it is, "Gnome Vibrator," is a product of G. I. Developments Ltd., London, England. The wash is placed in a sink of water and soap, and the Gnome shoots sound waves at 6,000 vibrations a minute, pressing the soapy water through the fabric. The manufacturers claim that it will clean and rinse safely every delicate material. In the sink of clear water (below) the sound waves can be seen.

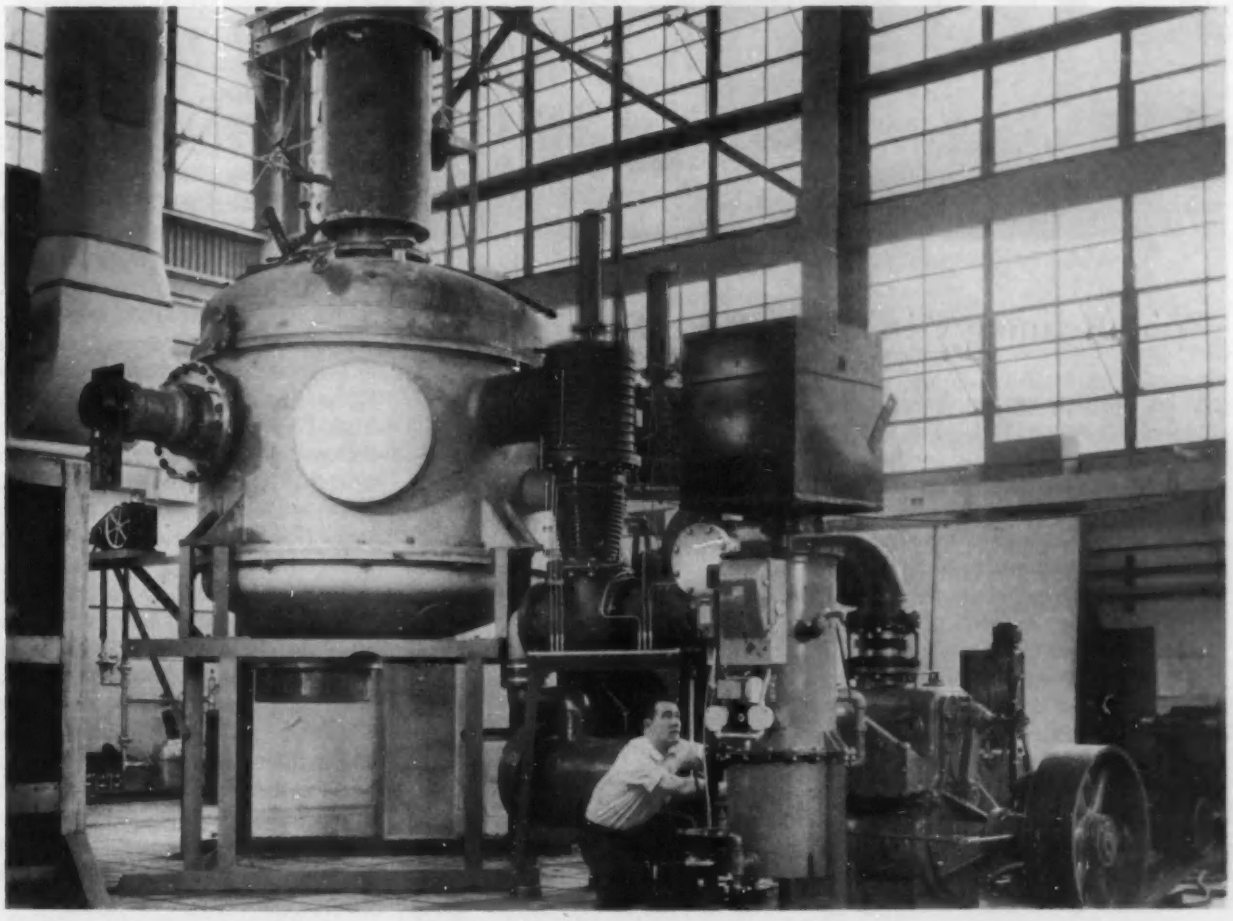


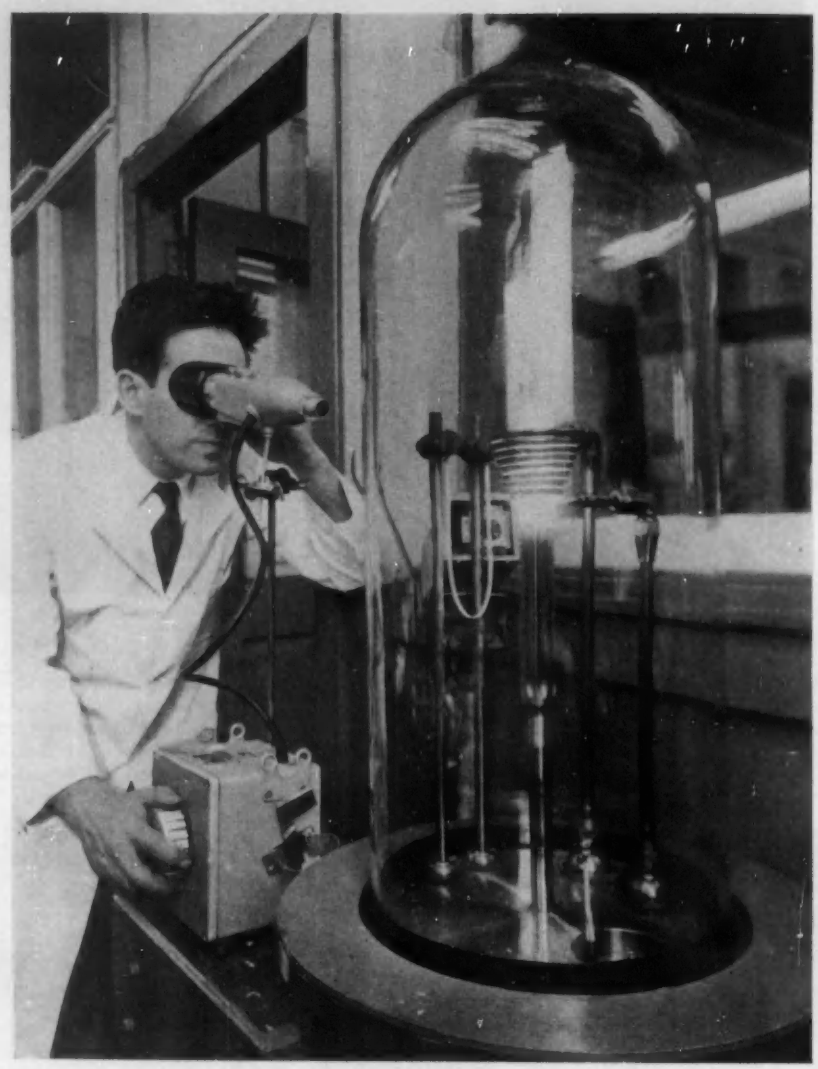
HARDLY VISIBLE HERE is what the Superior Tube Co. calls the world's smallest tube. The tube being measured has a 0.0014 in. O.D. and 0.0005 in. I.D., and is compared to a human hair above. The tube is cold drawn from 2 in. seamless nickel tubing, and requires 43 separate drawing operations with many intermediate controlled atmosphere annealing operations. Diamond dies are used to draw sizes from 0.115 in. and below. As yet the manufacturers have not come up with a suggestion for its commercial use.



THIS GAS-TIGHT ZIPPERED PLASTIC TENT is Solar Aircraft's answer to the problem of fusion welding titanium done at their Des Moines, Iowa plant. In its molten state, titanium will absorb gases such as oxygen, nitrogen, and hydrogen, all of which result in brittle welds. Therefore, the welding is done in a controlled atmosphere, by keeping air from the weld, and by bathing the work with an inert gas. When welding parts of this size, the tent is fastened to a standard welding table, and the welder uses long-sleeved rubber gloves sealed to the vinyl bag, for access to the part. Most of the titanium parts are for aircraft use.

SAID TO BE THE FIRST OF ITS KIND, this modular type, 1,000 lb. capacity high-vacuum furnace offers flexibility in operational technique, and permits economical expansion to larger capacities. The unit was designed by the Consolidated Vacuum Corp. for Westinghouse Electric Corp. who will melt a 350 lb. charge and pour a single ingot. By interchanging the crucible-coil assembly and furnace bottom, and by adding vacuum interlocks and a second large capacity vacuum pump, this 350 lb. furnace can be expanded to 1,000 lb. capacity for semi-continuous operation, and will permit pouring of single, multiple, or centrifugal cast ingots. All alterations can be made without disturbing the basic installation.





Zone Refining Gets Super-Pure Titanium

A bar of titanium is shown being pushed up slowly through a heating coil which melts the bar progressively from top to bottom. This process used at the Westinghouse Research Laboratories, is called cage zone refining and is carried on in an inert atmosphere of argon or helium gas inside a bell jar. The melted titanium is trapped inside a bar of the metal itself in order to prevent contamination by any containing crucible. The process is also used in transistor research to prepare germanium having impurities of about one part in ten billion.

The success of zone refining depends upon the fact that most impurities in metals have a preference for either the liquid or solid state of the metal. Iron, a common impurity in titanium, has a preference for liquid titanium over the solid metal. Consequently, when a bar of impure titanium is melted progressively from end to end, the iron tends to concentrate in the liquid titanium and remain there as the solid metal freezes out behind it. Thus, the iron is swept to one end of the bar as the molten zone moves along. The process can be repeated, after which the end of the bar is cut off.

The heating is done electromagnetically by passing the bar through a coil carrying high frequency a-c at 10,000 cps. The resulting eddy currents inside the bar cause it to melt from the inside out.

Miniature Aircraft Computer

Called a "miniature electronic brain" that can operate in planes flying at supersonic speed, a new digital computer developed by the Bell Telephone Laboratories for the Air Force contains 800 transistors, and is believed to be the first all-transistor computer designed for aircraft. Known as TRADIC, the device requires less than 100 watts to operate and will occupy less than 3 cu. feet. For navigation and fire control problems, a typical problem fed into the machine must go through about 250 different steps of computation, coming up with an answer in about 15 thousandths of a second. The computer can handle simultaneously as many as thirteen 16-digit numbers. Mathematical instructions are sent into the TRADIC by a plug-in unit resembling a small breadboard. Plug-in units are set up beforehand with interconnecting wires to represent the problems at hand. Numbers to be processed are fed into the machine by means of simple switches.

"Automation" A Misconception

"First let me say that the word 'automation' probably should be thrown in the wastebasket because of all the misconceptions it has generated." This was an early comment by Dr. W. R. G. Baker, G.E. Vice-Pres. and general manager of The Electronics Division in his speech at the recent Institute of Radio Engineers Convention in New York City. In the panel session on Automatic Control, Dr. Baker continued: "If it means mechanization, there is certainly nothing new about that. If it means automatic control of mechanical processes, there is nothing new about that either. In reality, automation is simply an all-embracing term that has been freely—and somewhat carelessly—used to refer to what is nothing more than the continuing advancement of the mechanization and automative control concepts that have been with us ever since the start of our industrial development."

"The major difference, as I see it, between automation and mechanization is that automation requires the

use of electronic programming, through computers and feedback principles, thus resulting in greater flexibility of operation. To the original tools of mechanization, mechanics, hydraulics, and pneumatics, we add the tools of programming and computing."

From the viewpoint of the designer or the manufacturer, the problems of automation differ little from the problems of mechanization.

News Brief

An increasing interest in the utilization of aluminum in the electrical industry was shown by the attendance of more than 600 engineers from the U. S. and Canada in a recent three-day AIEE conference at Pittsburgh, Pa. Thirty-eight papers in eight separate sessions covered the field from power distribution conductors and equipment, to the use of aluminum for electrical appliances. While emphasis was on the application of aluminum as conductors in power distribution and rotating machinery, the increasing use of this material for motor and equipment die castings and bearings was also discussed.

The first Machine Design Conference by The Machine Design Div. of the ASME was held recently at The New York University with about 200 design engineers attending. To make such a meeting an annual affair, an announcement was made that the next meeting will take place next April in Worcester, Mass.

Theme of the recent meeting was "Designing for Production." Seven production authorities from industry presented papers, with a discussion following each. Emphasis was placed on the necessity for close cooperation and mutual trust between engineering and production departments. It was generally agreed that a real problem exists in making the designer aware of production considerations at early stages in the design; yet there was no universal agreement on how this can best be accomplished. Industry representatives suggested training programs in colleges on factory practices but obtained rebuttal from educators that the high degree of industrial specialization makes this impractical, especially in a four-year curriculum.

Coming Events

MAY 16-20

1955 National Materials Handling Exposition, International Amphitheatre, Chicago, Ill. More than 200 companies expected to participate. Theme of the show is: "The Concept of Obsolescence", emphasizing that most handling equipment put into use in recent years is already outmoded by great advances in the field.

MAY 23-25

Ninth Annual Convention of the American Society for Quality Control, Hotels Statler and New Yorker, New York City. Representatives of more than 75 of the largest corporations will attend, in addition to people from the Dept. of Defense, Army, Navy, American Iron & Steel Institute, and ASA.

JUNE 2-3

1955 I.R.E. Materials Symposium, Convention Hall, Philadelphia, Pa. Jointly sponsored by the Philadelphia section of the Professional Group on Components. Keynote of the papers will be engineering materials for electrical and electronic applications.

JUNE 5-10

ASME Oil & Gas Power Conference at the Hotel Statler, Washington, D. C.

JUNE 7-10

American Welding Society's National Spring Meeting, Hotel Muehlebach, Kansas City, Mo. To be held in conjunction with the annual Welding Show. Thirty-nine papers will be present at the meeting, with discussions on: use of quenched and tempered steel for welded pressure vessels; use of iron powder coated electrodes; uses of carbon dioxide as a shielding gas in gas-shielded metal arc welding. Two sessions will be on Weldability and Research, and a third will cover the coordination of the society's standards and specifications. There will be sessions on welding for aircraft, and for machine and building structures.

JUNE 15-17

International Conference on Combustion jointly sponsored by the ASME and its British counterpart, the Institute of Mechanical Engineers, at MIT, Boston, Mass.

JUNE 16-18

ASME Applied Mechanics Conference, at Rensselaer Polytechnic Institute, Troy, N. Y.

JUNE 19-23

Semi-Annual Meeting, American Society of Mechanical Engineers, Hotel Statler, Boston, Mass.

JUNE 20-23

American Electroplaters Society, 42nd Annual Convention, Cleveland, Ohio. The Industrial Finishing Exposition will be held concurrently in the Public Hall. Titles of some of the papers are: Plating Powdered Metallurgy Bronze Parts; High Speed Brass Plating; Surface Preparation; Fatigue of Plated Steel Parts; Finishing and Plating of Beryllium and Beryllium Alloy; Vacuum Metallizing and others.

JUNE 20-JULY 1

"Creative Engineering and Product Design," Massachusetts Institute of Technology. This program was originated to help industry's demand for new ideas and products. Emphasis will be placed on the management of creative personnel. Registrants urged to bring company problems. Contact: Summer Session Office, Room 7-103, MIT, Cambridge 39, Mass.

JUNE 25-JULY 1

American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J. A number of papers will be presented at the following symposiums: Speed of Testing of Non-Metallic Materials; Impact Testing; Atmospheric Corrosion; Metallic Materials for Service at Temperatures above 1600 F; and High Purity Water Corrosion.

Aug. 24-26

Western Electronic Show and Convention, San Francisco, Calif. The show will be held at the Civic Auditorium, with Convention Headquarters at the Fairmont Hotel. For full particulars contact: Mal Mobley, Jr., WESCON, 344 N. La Brea Ave., Los Angeles 36, Calif.

low-cost "work horse"

for heavy duty jobs

Automatic Electric Class "A" Relays are still "healthy" even after 100,000,000 operations!

Here's a relay built for hard work, and every critical point shows it!

Contact points are formed and life-welded to the spring in one operation. An exclusive armature backstop design prevents armature freezing. A heavy-duty armature bearing is available for unusually heavy spring loads, or constant high-speed use.

Optional "long" or "short" lever armatures offer one lever-ratio for normal operating speeds . . . another for slow-to-release action, providing a residual gap which holds the required release timing, even under heavy-duty conditions. When extreme conditions suggest added precaution, an armature damper spring may also be supplied to eliminate wear from induced vibration.

For complete details, write for Circular 1800. Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

Dimensions

Overall length, 4"—Width, single pile-up 1¼"—double pile-up 1⅞"—Height (depending upon the number of springs), Series AQA and ASO 1⅝"; Series ASR and ASA 1⅝"-2".

Four different types

Of Class "A" Relays are available to meet your needs: Series AQA—Quick-Acting, DC; Series ASO—Slow-Operating, DC; Series ASR—Slow-Releasing, DC; and Series ASA—Slow-Acting, DC.

Contacts

Normally single, but can be supplied with twin contacts. Load carrying capacity, 150 watts (maximum 3 amps., non-inductive).

Contact spring capacity

Can be supplied with single or double pile-ups. Series AQA and ASO, 13 springs per pile-up; Series ASR and ASA, 6 springs per pile-up. (More contacts can be accommodated at a sacrifice of operating speed and release time delay.)

Evaluating Pythagorean Equations

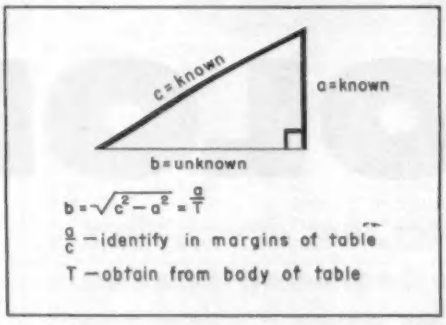
ERNEST L. SCHLAGE
Chief Engineer, Schlage Lock Co.

THE SOLUTION of $c^2 = a^2 + b^2$, although simple, entails three dissimilar arithmetic operations. A table has been devised to speed the calculations.

When solving $b = \sqrt{c^2 - a^2}$, determine a/c and match its first two digits with a number in the left margin of the table and the third digit with a number in the top margin, thus obtaining T from the body of the table. Divide a by T to obtain b. For a value of a/c = 0.426, T = 0.4709.

When solving $c = \sqrt{a^2 + b^2}$, choose a smaller than b for greater accuracy. Match the ratio a/b with a number in table and select M from the margins.

If interpolation is needed, the average difference between successive tabulated values for each row is shown in the last column.



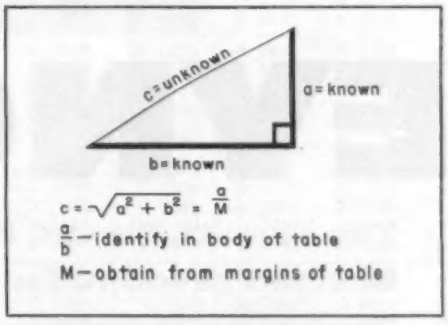


TABLE OF PYTHAGOREAN DIVISORS

	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Diff.
0.00	0.0000	0.0010	0.0020	0.0030	0.0040	0.0050	0.0060	0.0070	0.0080	0.0090	0.0010
0.01	0.0100	0.0110	0.0120	0.0130	0.0140	0.0150	0.0160	0.0170	0.0180	0.0190	0.0010
0.02	0.0200	0.0210	0.0220	0.0230	0.0240	0.0250	0.0260	0.0270	0.0280	0.0290	0.0010
0.03	0.0300	0.0310	0.0320	0.0330	0.0340	0.0350	0.0360	0.0370	0.0380	0.0390	0.0010
0.04	0.0400	0.0410	0.0420	0.0430	0.0440	0.0450	0.0461	0.0471	0.0481	0.0491	0.0010
0.05	0.0501	0.0511	0.0521	0.0531	0.0541	0.0551	0.0561	0.0571	0.0581	0.0591	0.0010
0.06	0.0601	0.0611	0.0621	0.0631	0.0641	0.0651	0.0661	0.0672	0.0682	0.0692	0.0010
0.07	0.0702	0.0712	0.0722	0.0732	0.0742	0.0752	0.0762	0.0772	0.0782	0.0792	0.0010
0.08	0.0803	0.0813	0.0823	0.0833	0.0843	0.0853	0.0863	0.0873	0.0884	0.0894	0.0010
0.09	0.0904	0.0914	0.0924	0.0934	0.0944	0.0954	0.0964	0.0975	0.0985	0.0995	0.0010
0.10	0.1005	0.1015	0.1025	0.1036	0.1046	0.1056	0.1066	0.1076	0.1086	0.1097	0.0010
0.11	0.1107	0.1117	0.1127	0.1137	0.1147	0.1158	0.1168	0.1178	0.1188	0.1198	0.0010
0.12	0.1209	0.1219	0.1229	0.1239	0.1250	0.1260	0.1270	0.1280	0.1291	0.1301	0.0010
0.13	0.1311	0.1321	0.1332	0.1342	0.1352	0.1363	0.1373	0.1383	0.1393	0.1404	0.0010
0.14	0.1414	0.1424	0.1435	0.1445	0.1455	0.1465	0.1476	0.1486	0.1496	0.1507	0.0010
0.15	0.1517	0.1528	0.1538	0.1548	0.1559	0.1569	0.1579	0.1590	0.1600	0.1611	0.0010
0.16	0.1621	0.1631	0.1642	0.1652	0.1662	0.1763	0.1683	0.1694	0.1704	0.1715	0.0010
0.17	0.1725	0.1736	0.1746	0.1756	0.1767	0.1777	0.1788	0.1798	0.1809	0.1819	0.0010
0.18	0.1830	0.1840	0.1851	0.1862	0.1872	0.1882	0.1893	0.1404	0.1914	0.1925	0.0011
0.19	0.1935	0.1946	0.1956	0.1967	0.1978	0.1988	0.1999	0.2009	0.2020	0.2031	0.0011
0.20	0.2041	0.2052	0.2063	0.2073	0.2084	0.2095	0.2105	0.2116	0.2126	0.2137	0.0011
0.21	0.2148	0.2159	0.2169	0.2180	0.2191	0.2202	0.2212	0.2223	0.2234	0.2244	0.0011
0.22	0.2255	0.2266	0.2277	0.2288	0.2298	0.2909	0.2320	0.2331	0.2342	0.2352	0.0011
0.23	0.2363	0.2374	0.2385	0.2396	0.2407	0.2418	0.2429	0.2439	0.2450	0.2461	0.0011
0.24	0.2472	0.2483	0.2494	0.2505	0.2516	0.2527	0.2538	0.2549	0.2560	0.2571	0.0011
0.25	0.2582	0.2593	0.2604	0.2615	0.2626	0.2637	0.2648	0.2659	0.2670	0.2682	0.0011
0.26	0.2693	0.2704	0.2715	0.2726	0.273	0.2748	0.2759	0.2771	0.2782	0.2793	0.0011
0.27	0.2804	0.2815	0.2827	0.2838	0.2849	0.2860	0.2872	0.2883	0.2894	0.2905	0.0011
0.28	0.2917	0.2928	0.2939	0.2951	0.2962	0.2973	0.2985	0.2996	0.3007	0 3019	0.0011
0.29	0.3030	0.3042	0.3053	0.3065	0.3076	0.3087	0.3099	0.3110	0.3122	0 3133	0.0012

(*continued on page 203*)

PVA

polyvinyl alcohol

REYNOLON

The Quality Plastic Film that offers New Design Freedom, Cuts Costs and Speeds Production of Reinforced Plastic Products

Aircraft, automotive, architectural, boat and many other industries have found bag molding with Reynolon Polyvinyl Alcohol Film permits greater freedom of design, offers economy, and facilitates getting into production quicker on new parts or complete products.

Plastic bag molds can be made faster and at lower cost than matched metal parts. Also—the high elongation characteristics of Reynolon Polyvinyl Alcohol Film as well as its non-inhibiting and clean separating qualities make it ideal in molding reinforced plastics.

Highest quality, clear, strong Reynolon Polyvinyl Alcohol, Polyvinyl Chloride, Polyethylene and laminates of Polyethylene and Cellophane are all available in many standard specifications or can be economically produced for your specialized requirements. Our Technical Product Development Service is also available to you without obligation.

Photos courtesy of Olympic Reinforced Plastics Corp.

Illustrated above is a reinforced plastic layup made on a temporary sectional die and enclosed in Reynolon 4000 Series Polyvinyl Alcohol Film.

Above, vacuum pressure applied by Reynolon 4000 Series Polyvinyl Alcohol Film assures a compact laminate with a minimum of surface voids on mold line.

Illustrated above is the completed component—a reinforced plastic architectural panel—removed from die, trimmed and ready for installation.

For complete information,
contact your nearest Reynolds Metals Company office or write

PLASTICS DIVISION,
REYNOLDS METALS COMPANY
3802 GEORGIA STREET • GARY, INDIANA

PRODUCT ENGINEERING - REFERENCE BOOK SHEET

Table of Pythagorean Divisions (continued from page 201)

	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Diff.
0.30	0.3145	0.3156	0.3168	0.3179	0.3191	0.3203	0.3214	0.3226	0.3237	0.3249	0.0012
0.31	0.3261	0.3272	0.3284	0.3296	0.3307	0.3319	0.3331	0.3342	0.3354	0.3366	0.0012
0.32	0.3378	0.3389	0.3401	0.3413	0.3425	0.3437	0.3448	0.3450	0.3472	0.3484	0.0012
0.33	0.3496	0.3508	0.3520	0.3532	0.3544	0.3556	0.3567	0.3579	0.3591	0.3603	0.0012
0.34	0.3615	0.3627	0.3640	0.3652	0.3664	0.3676	0.3688	0.3700	0.3712	0.3724	0.0012
0.35	0.3736	0.3748	0.3761	0.3773	0.3785	0.3797	0.3810	0.3822	0.3834	0.3846	0.0012
0.36	0.3859	0.3871	0.3883	0.3896	0.3909	0.3921	0.3933	0.3945	0.3958	0.3970	0.0012
0.37	0.3983	0.3995	0.4008	0.4020	0.4033	0.4045	0.4058	0.4070	0.4083	0.4096	0.0013
0.38	0.4108	0.4121	0.4134	0.4146	0.4159	0.4172	0.4184	0.4197	0.4210	0.4223	0.0013
0.39	0.4235	0.4248	0.4261	0.4274	0.4287	0.4300	0.4312	0.4326	0.4338	0.4351	0.0013
0.40	0.4364	0.4377	0.4390	0.4403	0.4416	0.4430	0.4443	0.4456	0.4469	0.4482	0.0013
0.41	0.4495	0.4508	0.4522	0.4535	0.4548	0.4561	0.4575	0.4588	0.4601	0.4615	0.0013
0.42	0.4628	0.4641	0.4655	0.4668	0.4682	0.4695	0.4709	0.4722	0.4736	0.4749	0.0014
0.43	0.4763	0.4776	0.4790	0.4804	0.4817	0.4831	0.4845	0.4859	0.4872	0.4886	0.0014
0.44	0.4900	0.4914	0.4928	0.4941	0.4955	0.4969	0.4983	0.4997	0.5011	0.5025	0.0014
0.45	0.5039	0.5053	0.5067	0.5081	0.5095	0.5110	0.5124	0.5138	0.5152	0.5166	0.0014
0.46	0.5180	0.5195	0.5209	0.5224	0.5238	0.5252	0.5267	0.5281	0.5296	0.5310	0.0015
0.47	0.5325	0.5339	0.5354	0.5368	0.5383	0.5398	0.5412	0.5427	0.5442	0.5457	0.0015
0.48	0.5471	0.5486	0.5501	0.5516	0.5531	0.5546	0.5561	0.5576	0.5591	0.5606	0.0015
0.49	0.5621	0.5636	0.5651	0.5666	0.5682	0.5697	0.5712	0.5728	0.5743	0.5758	0.0015
0.50	0.5774	0.5789	0.5804	0.5820	0.5835	0.5851	0.5866	0.5882	0.5898	0.5913	0.0016
0.51	0.5929	0.5945	0.5960	0.5976	0.5992	0.6008	0.6024	0.6040	0.6056	0.6072	0.0016
0.52	0.6088	0.6104	0.6120	0.6136	0.6152	0.6168	0.6185	0.6201	0.6217	0.6234	0.0016
0.53	0.6250	0.6266	0.6283	0.6299	0.6316	0.6332	0.6349	0.6366	0.6382	0.6399	0.0017
0.54	0.6416	0.6433	0.6450	0.6466	0.6483	0.6500	0.6517	0.6534	0.6551	0.6568	0.0017
0.55	0.6586	0.6603	0.6620	0.6637	0.6655	0.6672	0.6689	0.6707	0.6724	0.6742	0.0017
0.56	0.6759	0.6777	0.6794	0.6812	0.6830	0.6848	0.6866	0.6883	0.6901	0.6919	0.0018
0.57	0.6937	0.6955	0.6974	0.6992	0.7010	0.7028	0.7046	0.7065	0.7083	0.7101	0.0018
0.58	0.7120	0.7138	0.7157	0.7176	0.7194	0.7213	0.7232	0.7251	0.7269	0.7288	0.0019
0.59	0.7307	0.7326	0.7345	0.7365	0.7384	0.7403	0.7422	0.7442	0.7461	0.7480	0.0019
0.60	0.7500	0.7520	0.7539	0.7559	0.7579	0.7598	0.7618	0.7638	0.7658	0.7678	0.0020
0.61	0.7698	0.7718	0.7738	0.7759	0.7779	0.7799	0.7820	0.7840	0.7861	0.7881	0.0020
0.62	0.7902	0.7923	0.7944	0.7965	0.7985	0.8006	0.8028	0.8049	0.8070	0.8091	0.0021
0.63	0.8112	0.8134	0.8155	0.8177	0.8198	0.8220	0.8242	0.8263	0.8285	0.8307	0.0022
0.64	0.8329	0.8351	0.8373	0.8396	0.8418	0.8441	0.8463	0.8485	0.8508	0.8531	0.0022
0.65	0.8553	0.8576	0.8599	0.8622	0.8645	0.8668	0.8692	0.8715	0.8738	0.8762	0.0023
0.66	0.8785	0.8809	0.8833	0.8856	0.8880	0.8904	0.8928	0.8952	0.8977	0.9001	0.0024
0.67	0.9025	0.9050	0.9074	0.9099	0.9124	0.9149	0.9174	0.9199	0.9224	0.9249	0.0025
0.68	0.9274	0.9300	0.9325	0.9351	0.9377	0.9402	0.9428	0.9454	0.9480	0.9507	0.0026
0.69	0.9533	0.9559	0.9586	0.9612	0.9639	0.9666	0.9693	0.9720	0.9747	0.9775	0.0027
0.70	0.9802	0.9829	0.9857	0.9885	0.9913	0.9941	0.9969	0.9997	1.003	1.005	0.0028
0.71	1.008	1.011	1.014	1.017	1.020	1.023	1.026	1.029	1.032	1.035	0.003
0.72	1.037	1.040	1.044	1.047	1.050	1.053	1.056	1.059	1.062	1.065	0.003
0.73	1.068	1.071	1.074	1.078	1.081	1.084	1.087	1.090	1.094	1.097	0.003
0.74	1.100	1.104	1.107	1.110	1.113	1.117	1.120	1.124	1.127	1.130	0.003
0.75	1.134	1.137	1.141	1.144	1.148	1.151	1.155	1.159	1.162	1.166	0.004
0.76	1.169	1.173	1.177	1.180	1.184	1.188	1.192	1.195	1.199	1.203	0.004
0.77	1.207	1.211	1.215	1.218	1.222	1.226	1.230	1.234	1.238	1.242	0.004
0.78	1.246	1.251	1.255	1.259	1.263	1.267	1.271	1.276	1.280	1.284	0.004
0.79	1.289	1.293	1.297	1.302	1.306	1.311	1.315	1.320	1.324	1.329	0.004
0.80	1.333	1.338	1.343	1.347	1.352	1.357	1.362	1.367	1.371	1.376	0.005
0.81	1.381	1.386	1.391	1.396	1.401	1.406	1.412	1.417	1.422	1.427	0.005
0.82	1.433	1.438	1.443	1.449	1.454	1.460	1.465	1.471	1.477	1.482	0.006
0.83	1.488	1.494	1.500	1.506	1.512	1.518	1.524	1.530	1.536	1.542	0.006
0.84	1.548	1.554	1.561	1.567	1.574	1.580	1.587	1.593	1.600	1.607	0.007
0.85	1.614	1.620	1.627	1.634	1.641	1.649	1.656	1.663	1.670	1.768	0.007
0.86	1.685	1.693	1.701	1.708	1.716	1.724	1.732	1.740	1.748	1.756	0.008
0.87	1.765	1.773	1.781	1.790	1.799	1.807	1.816	1.825	1.834	1.843	0.009
0.88	1.853	1.862	1.872	1.881	1.891	1.901	1.911	1.921	1.931	1.941	0.010
0.89	1.952	1.963	1.973	1.984	1.995	2.006	2.018	2.029	2.041	2.053	0.011
0.90	2.065	2.077	2.089	2.102	2.114	2.127	2.140	2.154	2.167	2.181	0.013
0.91	2.195	2.209	2.223	2.238	2.253	2.268	2.283	2.299	2.315	2.331	0.015
0.92	2.347	2.364	2.381	2.399	2.416	2.434	2.453	2.472	2.491	2.510	0.018
0.93	2.530	2.551	2.571	2.593	2.614	2.636	2.659	2.682	2.706	2.730	0.022
0.94	2.755	2.781	2.807	2.834	2.861	2.889	2.918	2.948	2.979	3.010	0.029
0.95	3.042	3.076	3.110	3.146	3.182	3.220	3.259	3.299	3.341	3.384	.....
0.96	3.429	3.475	3.523	3.573	3.625	3.680	3.736	3.796	3.857	3.922	.....
0.97	3.990	4.061	4.137	4.216	4.299	4.388	4.482	4.582	4.688	4.802	.....
0.98	4.925	5.056	5.199	5.354	5.523	5.709	5.913	6.141	6.397	6.686	.....
0.99	7.018	7.403	7.858	8.407	9.087	9.962	11.15	12.88	15.79	22.34	.....

If you **MUST** stop Corrosion

KEL-F® PLASTIC WILL

KEL-F Plastic Molded and Fabricated Valve Linings, Valve Diaphragms, Gaskets, Ring Seals, Gauge Crystals, KEL-F Dispersion Coated or Laminated Lined Tanks, Vessels, Reactors, Piping and Tubing can protect your plant equipment against chemical corrosion

KEL-F Fluorocarbon Plastic is the best non-permeable, corrosion-proof material available today. It is inert to virtually any type of chemical attack—including mineral acids, oxidizing agents as well as strong caustics. When nothing else will protect equipment, KEL-F Plastic usually will.

HERE ARE SOME OF ITS OUTSTANDING CHARACTERISTICS:

Temperature Tolerance

Exhibits satisfactory properties over a temperature range of approximately 710° F. (—320° F. to 390° F.)

High Compressive Strength

Pressures of 8,000 psi result in only 4% to 5% permanent set. Line seals are retained longer when gaskets and O-ring seals are made of KEL-F Plastics.

Non-Adhesive

KEL-F Plastic is non-wetting even after long periods of immersion. Surface is anti-fouling when in contact with even the most viscous liquids.

KEL-F Plastic is a thermoplastic and easy to fabricate. It is readily molded by extrusion, transfor and injection. Available in sheets, rods, tubing and film, it can be fabricated, heat formed, machined and heat-sealed by a growing list of experienced fabricators.

New! KEL-F Plastic Dispersions

KEL-F Plastic Dispersions have been developed for bake-coating of metallic surfaces that must be corrosion resistant, anti-adhesive and electrically non-conductive. These Dispersions can be applied by spraying, spreading or dipping.

The full story of what KEL-F will do for you is worth having. Write or call for additional information.

KELLOGG

THE M. W. KELLOGG COMPANY

Chemical Manufacturing Division,
P. O. Box 469, Jersey City, N. J.

SUBSIDIARY OF PULLMAN INCORPORATED

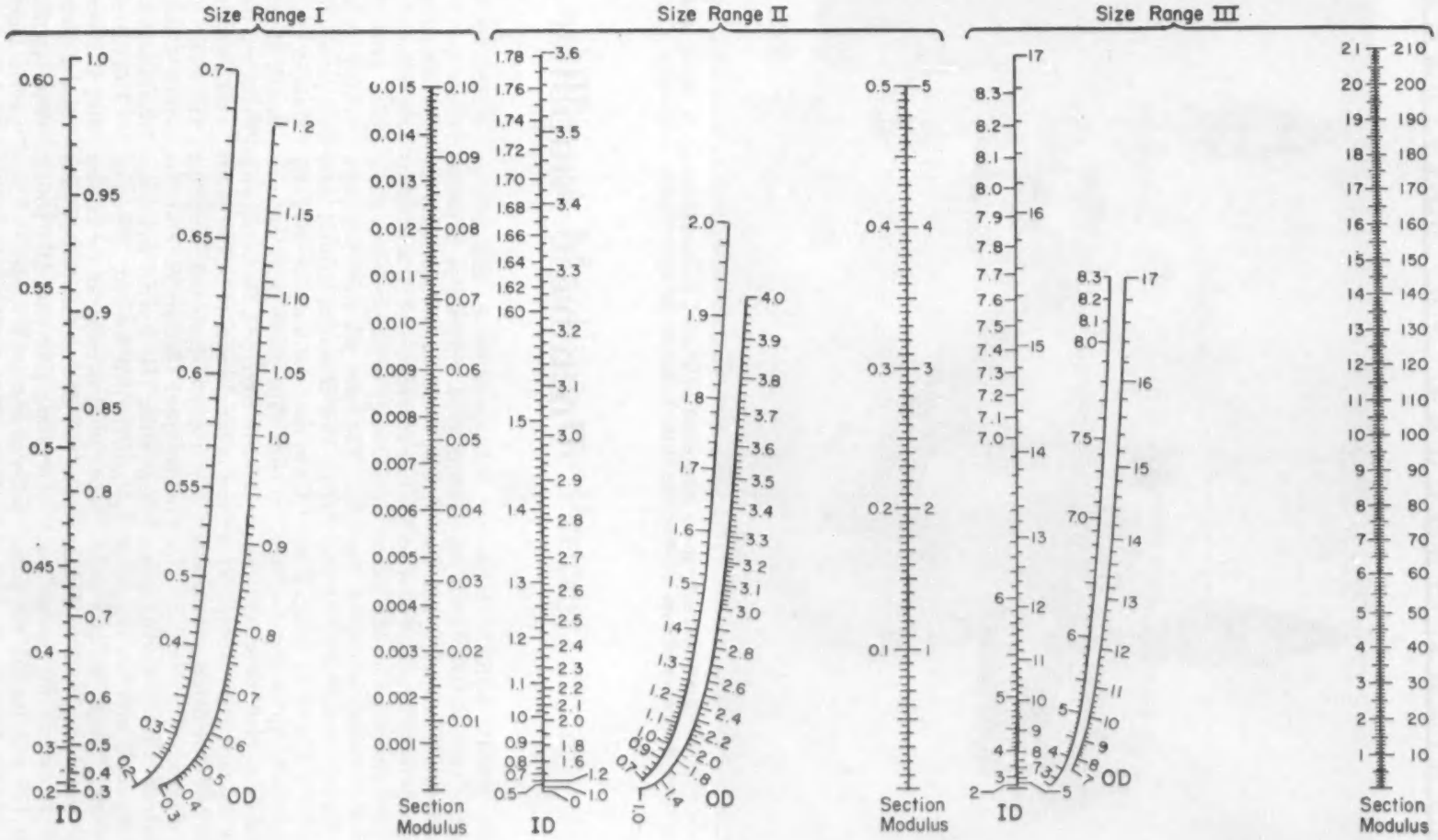
® Registered trademark of The M. W. Kellogg Company's fluorocarbon polymers.

Nomograph for Section Modulus of Pipes, Tubes and Shafts*

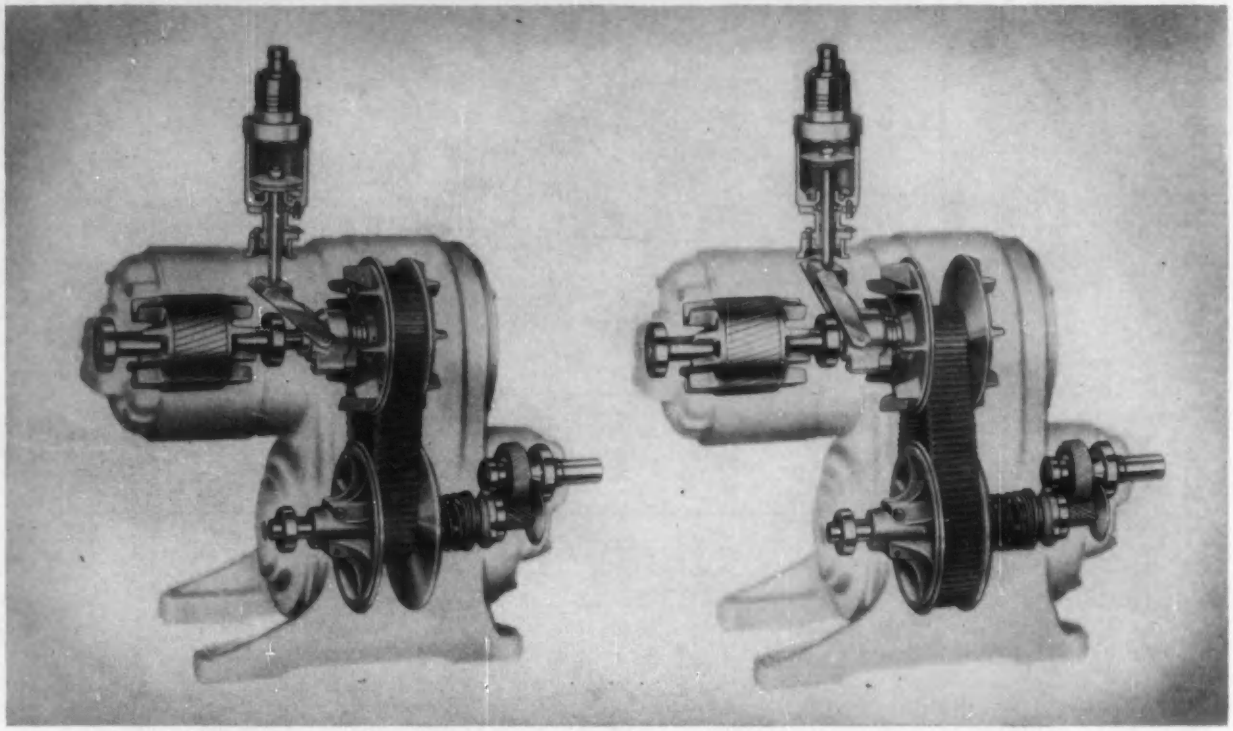
JAMES J. KERLEY, JR., VITRO LABORATORIES

This chart solves the following equation for the section modulus of pipes, tubes and hollow shafts:

$$\text{Section Modulus} = \frac{\pi\,(OD)^4 - \pi\,(ID)^4}{32\,(OD)}$$



*Ref: Design Nomograms by James J. Kerley, Jr.; published by Gulbart Press, 6203 Forest Rd., Cheverly, Md., $3.00.



FAST OUTPUT SPEED POSITION of the control-and-drive unit's piston and linkage is shown on the left. At the right, low-speed position is represented with movable disc of the pulley moved away from its companion.

Pneumatic Amplifier and Motor

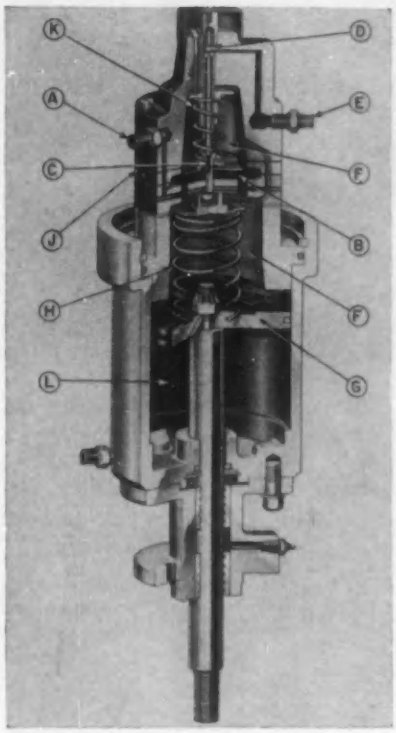
Speed, pressure, liquid level, temperature or other variable factors can be automatically controlled and the machine operation or process powered by a pneumatic amplifier and motor combination recently introduced. Basically, the unit consists of: 1) an electric motor of 1 to 60 hp rating; 2) an amplifier made up of a piston, mechanical linkage and the necessary regulatory and valving components; 3) a stepless belt drive having a changeable pulley diameter.

Operation of the controlling system is accomplished with two degrees of air pressure. "Signal" air, at 3 to 15 psi, is the sensing and controlling means. It controls the "power" air (60 to 100 psi) through the pneumatic amplifier, operating the linkage governing output speed of the unit.

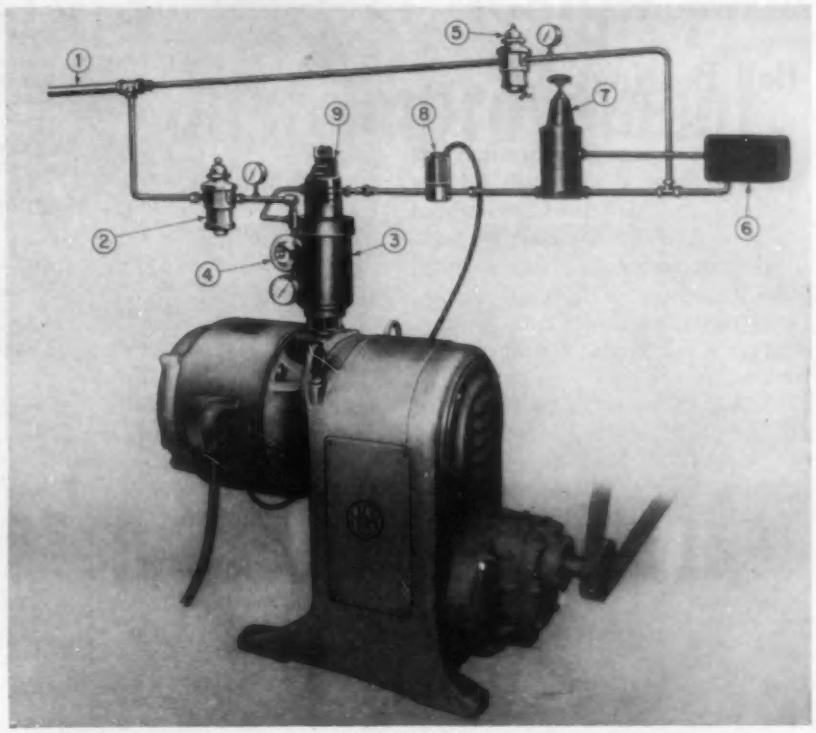
A change in one of a machine's operating cycle elements or a process variable causes an increase in the signal air connected (see A, accompanying drawing) to the pneumatic amplifier. This raises the unit's diaphragm (B). This causes the exhaust valve (C) to close and the pilot valve (D) to open. The power air is then permitted to enter (E), increasing pressure in the chamber (F). The piston (G) is driven downward, increasing output speed. Because force on the range spring (H) is reduced, the diaphragm (B) is lowered, decreasing power air by bleeding out the exhaust valve (C) through exit port (J) and by throttling pilot valve (D) until a balanced situation is reached.

When the conditions in machine operation or process sequence causes a decrease in signal air pressure, the diaphragm (B) is lowered, causing the compression spring (K) to open the exhaust valve (C) and to close the pilot valve (D). This reduces the pressure in the chamber (F) above the piston. "Cushion" air in the lower chamber (L), supplied by a regulated branch of the power air supply at 3 to 15 psi, forces the piston (G) upward, reducing speed. The springs (H & K) compress, returning the valves (C and D) to a balanced, throttled condition.

This controlling unit is said to provide a constant relationship between signal pressure and output speed of the drive regardless of variation in any friction forces which may be developed. A low bleed rate of power air occurs from the positioner when cor-



PNEUMATIC AMPLIFIER, which uses air supply at 3 to 15 psi.



PNEUMATIC CIRCUIT, components and instruments for a typical application of the new control system. Explanation of system is included in text below.

Controls and Drives Machine or Process

rect drive speed has been effected. This provides a balance of forces in the unit.

An example of the pneumatic system required for the new control is shown in the accompanying photograph. An air supply (1) of 60 to 100 psi is filtered and regulated (2). This powers the downward thrust of the piston in the amplifier's cylinder (3). A branch of this power air is regulated (4) to 3 to 12 psi. and air cushion.

Another branch of the air supply is filtered and regulated (5) to 20 psi and sent as operating pressure to signal instruments. The signal transmitter (6) converts incoming messages concerning machine operating or processing variables to a 3 to 15 psi signal pressure. The controller (7) modifies this signal by changing sensitivity, rate of change or other factors. The signal then continues through the solenoid (8) to the positioner (9), where the flow of power air to the amplifier's cylinder is controlled. When the process or equipment being controlled shuts down, the solenoid valve (8) automatically returns the drive to low speed.

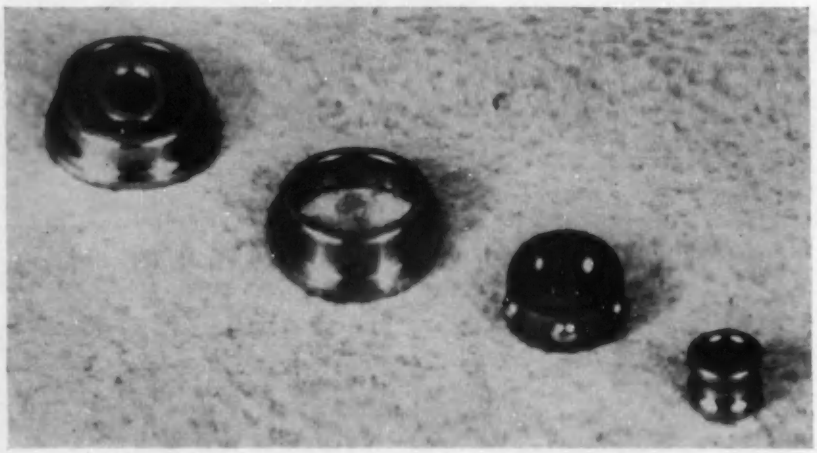
The signal system supplying information to the positioner may be any one of many standard types of control instruments. Because the particular type needed will be determined by the application, it is not supplied with the new control-and-drive unit. U. S. Electrical Motors, Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.

The motor commonly used with this new control system is of a constant speed, squirrel cage, polyphase a-c design. It is built into a mechanical variable speed transmission of the reciprocal diameter type. Where variable slow speeds are required, the drive is available in combination with this manufacturer's single or double reduction gearing to provide a compact, one-package unit. The motor can be supplied from ¼ to 60 hp ratings, with speeds from 2 to 10,000 rpm, in speed ranges of up to 10:1. Modifications and various assemblies are available, including totally-enclosed and explosion-proof designs. Besides the fully automatic control arrangements, various other devices can be supplied, including universal coupling, right angle drive, chain and sprocket, direct extension, pneumatic or hydraulic lever, flexible shaft.

For more information—
Circle 1, inside back cover

CONTINUED ON PAGE 208

Flanged, Separable Miniature Ball Bearings



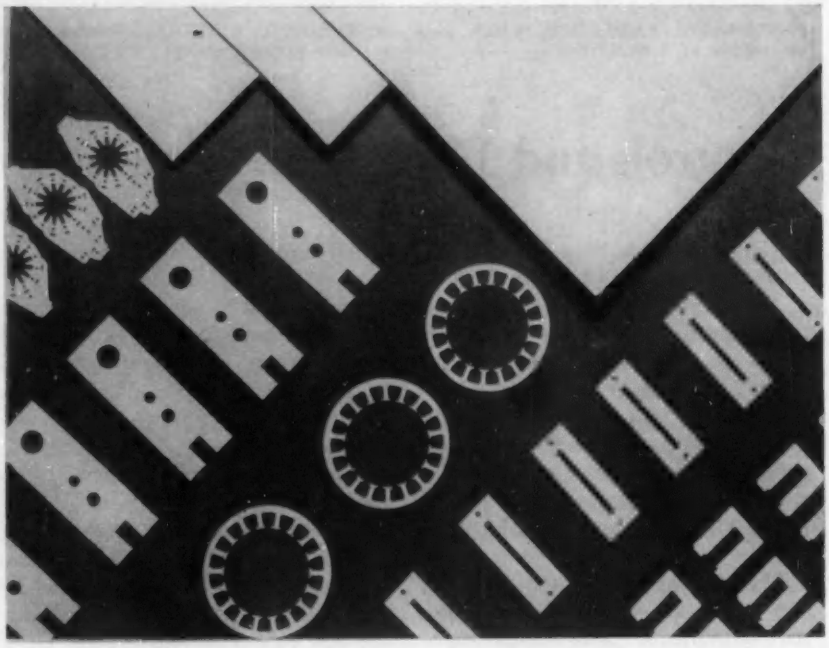
A series of separable minature ball bearings, designed specifically for easy assembly and high-speed applications are flanged to facilitate assembly without counterboring. The new magneto-type bearings are designed to support both radial and thrust loads in blowers, gyros, spin motors and other mechanisms.

Radial support of a shaft mounted in these bearings is not affected by slight axial play. Two of these angular contact, single-row bearings mounted in opposition control internal bearing clearance by axial adjustment. The high mass of the retainers, made of brass, stainless steel, or vacuum impregnated phenolic plastic for high temperature applications (over 200 F), assures long life at high speeds.

Manufactured to ABEC 5 tolerances in either SAE 52100 chrome bearing steel (60 Rc min) or 440 stainless (56 Rc min), the new bearings are assembled with either inner or outer race relieved. Four standard sizes, with bores ranging from 0.0550 in. to 0.1250 in. and outer diameters ranging from 0.1875 in. to 0.3125 in., are available. Miniature Precision Bearings, Inc., Keene, N. H.

For more information—
Circle 2, inside back cover

Laminates For Unusual Temperature-Humidity Conditions



Three grades of thermosetting laminated plastics utilizing a diallylphthylate resin base are now being produced. Due to its canvas filler, C-104 is said to be easily machined and has a high degree of dimensional stability. The power factor and dielectric constant of 0-104 (orlon) show very little change after NEMA water immersion tests. Grade G-104 (glass cloth) possessed the best electrical properties in the dry condition compared to other DAP grades, but shows higher rate of change when subjected to moisture.

Maximum operating temperatures vary slightly between grades. Laboratory tests indicate that the orlon laminate will withstand continuous temperatures of 225 F, canvas 275 F, and glass fabric 325 F, without affecting mechanical or electrical values.

All three of the new laminates are available in sheets and the canvas and glass cloth in tube form. All are available as parts fabricated to specifications. Sheet thickness ranges from $\frac{1}{32}$ to 1 in. in the case of canvas and orlon. The glass fabric laminate is available in sheets of $\frac{1}{64}$ to 1 in. thick. Synthane Corp., Oaks, Pa.

For more information—
Circle 3, inside back cover

CONTINUED ON PAGE 210

only CAMROL cam follower by McGILL offers original design plus 20 years of product improvement

TRADE MARK

50th
McGILL
Anniversary
First patented Cam Follower bearing.
First Cam Follower design lubricated from three different locations, increasing versatility of the bearing.
First to simplify design and construction to lower installation costs.
Other McGill Firsts:
First full type roller bearing.
First center guided roller bearing.
First fully sealed roller bearing.

The successful acceptance of repeated shock load in cam operation is the ultimate test of a cam follower bearing. In thousands of applications, the McGill CAMROL Cam Follower bearing has proved itself strictly on the basis of its performance, because it is designed and built specifically for withstanding the intermittent shock and heavy load of cam operation. Millions of CAMROL bearings are operating today in all kinds of industrial machinery.

McGill engineers recognized the need for an anti-friction Cam Follower and developed the first full-type roller bearing Cam Follower over 20 years ago. Imitation is the sincerest compliment to a successful product, and others have copied the outward appearance of CAMROL bearings.

McGill's years of application experience has improved the design and methods of manufacture that result in performance extras for the CF and CYR series. For instance, a combination of zone and through hardening are used to provide the right combination of hardness and toughness for maximum life.

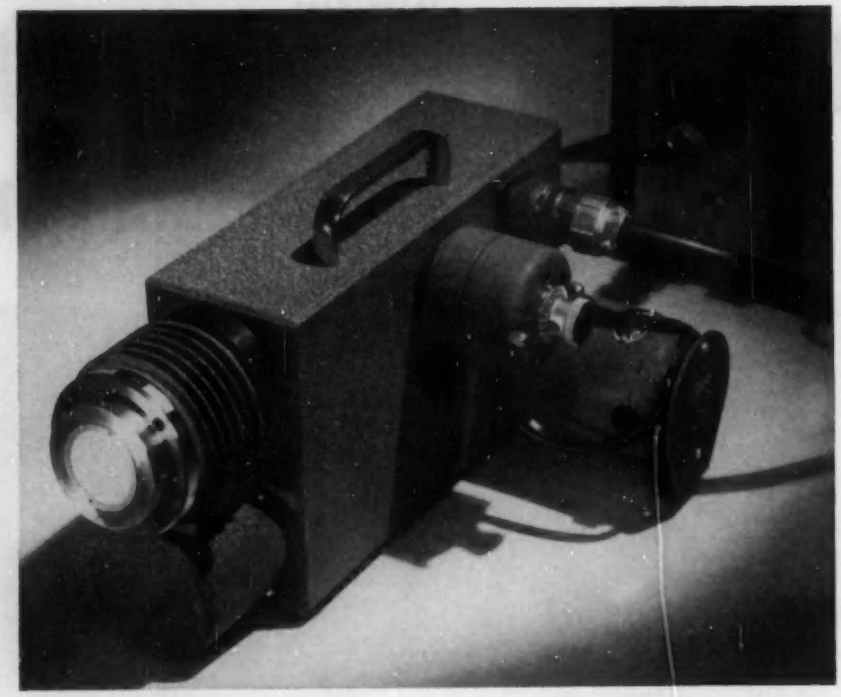
Full-type roller bearing construction gives the CAMROL CF bearing the ultimate in radial capacity, improving its load-carrying qualities to complement its resistance to shock. A soft stud stem adds toughness and permits reworking for slight dimensional changes.

The care and know-how that go into manufacture of bearing components are matched in assembly of parts. Parts are cleaned, assembled and greased under dust-free conditions to give you extra performance available only from a CAMROL Cam Follower by McGill.

McGILL MANUFACTURING COMPANY, INC.

BEARING DIVISION — 201 N. Lafayette Street, Valparaiso, Indiana

High-Speed Pressure Recorder



In a design employing interferometric optical principles, this recorder provides recording short-term pressure variations over a wide series of pressure ranges. The film record produced is suitable for rapid analysis and data reduction—a first approximation of pressure being available by the simple counting of the number of fringes.

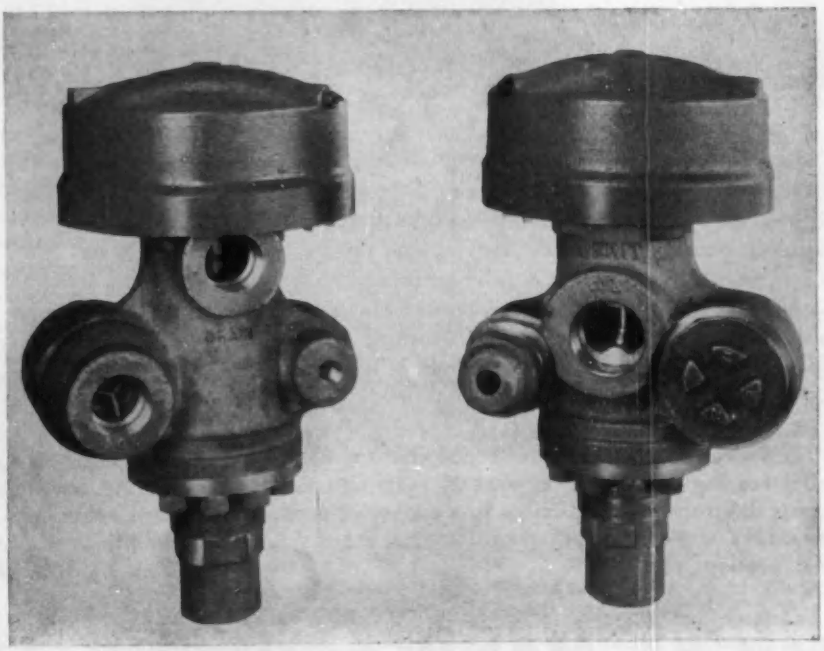
In application, the instrument can be utilized in three ways: (1) exposed to free air manifestations; (2) attached directly to a pressure vessel; (3) fed by a hydraulic line from the pressure source.

The combined transducer, optical system, and camera with 2-millisecond timing-pip system are all housed in a case 15¾ by 9¼ by 7¼ in. and weighing 25 lb. The control unit (housed in a standard 19-inch rack unit 7 in. high and 8½ in. deep, weighing 25 lbs) can be located remotely from the transducer. Complete control is exercised from this point, including the camera drive motor, dynamic braking system and the monochromatic light source which illuminates the transducer.

Since the instrument essentially measures the displacement of the transducer diaphragm, it is additionally adaptable for the measurement of any physical phenomena which can be translated into linear motion. Beckman & Whitley, Inc., 925 E. San Carlos, Calif.

For more information—
Circle 4, inside back cover

Two-Pressure Operating Valves for Hydraulic Cylinders



This valve is a cylinder operated, self-contained unit of three-way valve, controlled speed check valve and automatic high pressure inlet valve. Commonly used to supply cylinders or hydraulic press rams where low pressure can be used for traverse but where the higher pressures must be applied for squeeze or holding, these valves are usable on oil or water and will handle pressures to 3000 psi. Minimum satisfactory low pressure is about 100 psi for proper operation of the automatic inlet valve.

As air is applied to the cylinder top

CONTINUED ON PAGE 212

GEARS *that keep* AMERICA *on the* GO!

Gears turn horsepower into motion—whether for work or for pleasure. In vehicles of almost every description—from boats to heavy farm machinery—you'll find flywheel ring gears, transmission gears, differential drive gears, and other gears that are designed, engineered, and manufactured by Automotive Gear Works rendering the best possible service in the transmission of power.

If you have a product that serves up-and-going America it may be worth your while to learn how our staff and facilities can best be utilized to supply all your gear needs—and how we serve as the "gear department" for many leading manufacturers. Why not write today for further information?

DOUBLE DIAMOND TRADE MARK GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914

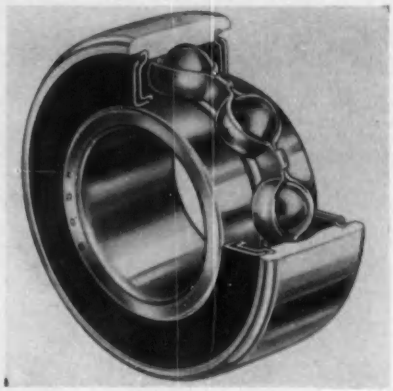
RICHMOND, INDIANA

of this valve, the spindle moves downward, first closing the drain or return line, then going on to open the low pressure supply through to the cylinder being operated. As long as this cylinder traverses freely before the incoming low pressure, the gage pressure in the cylinder line will be low and no high pressure is yet required.

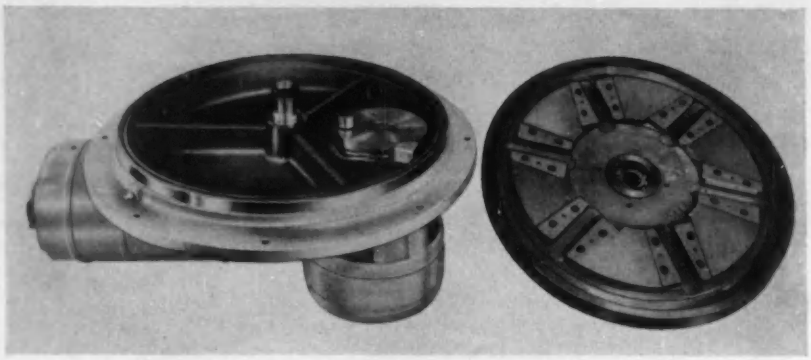
When resistance is met, this gage will jump to the full supply pressure, and as the pressure increases, the adjusting spring in the automatic high pressure inlet valve is overcome and that valve opens to admit high pressure. This resistance will already have slowed the inrush of low pressure, and the check valve will have already started closing to isolate the high pressure from the low pressure supply line.

These valves are available in pipe sizes ranging from 1 to 3 in. Emmet Machine & Mfg., Inc., 445 E. Turkeyfoot Lake Rd., Akron 19, Ohio.

For more information—
Circle 5, inside back cover



MECHANICAL COMPONENTS



Powered Index Tables

Available in 21 and 34 in. table diameters with 6, 8 or 12 stations, these tables are operated by a Geneva drive, using a needle-bearing cam follower operating in ways faced with hardened and ground tool steel wearing plates. According to the manufacturer it is impossible for this device to get out of time or mis-index.

The table is driven by a 220-440 v, three-phase, 60 cycle, 1800 rpm brake motor, through a bronze worm-and-gear reduction unit.

The table revolves on a large, double-row precision ball thrust bearing and the drive shaft from the reduction unit operates in precision ball bearings while the locking pin travels in hardened steel guides.

The 21-inch model is driven by a ¾ hp motor and has a load capacity of 400 lbs. with an indexing cycle of 1.5 sec under normal operating conditions. It may be equipped with top plates up to 32 in. dia and, with a work cycle of 3 sec, is capable of 800 operations an hour.

The 34-in. table, driven by a 1 hp motor, will carry an 800 lb load with an indexing cycle of 2 sec under normal operating conditions. It may be equipped with top plates up to 48 in. dia and, with a work cycle of 4 sec is capable of 600 operations an hour. Cleveland Tapping Machine Co., Canton, Ohio.

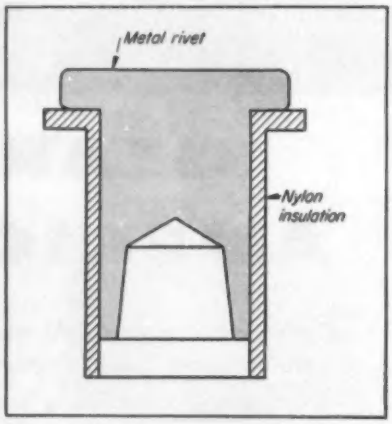
For more information—
Circle 6, inside back cover

Two Dished Plates Seal Ball Bearings

This series includes seven sizes. The inner steel sealing plate is fixed securely in the outer ring of the bearing and provides effective grease retention. The corrosion-resistant outer member is pressed on the outside diameter of the inner ring and rotates as a slinger to throw off contaminants.

These bearings have a wide width, which provides extra support on shafts and housings and is asserted to eliminate the need for locknuts and lockwashers on applications such as electric motors. They are available in bores of 0.9843 to 2.1654 in. Fafnir Bearing Co., New Britain, Conn.

For more information—
Circle 7, inside back cover

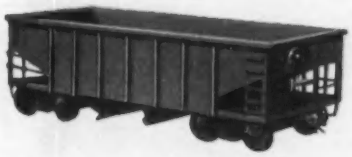


Insulated Metal Rivets

These fasteners consist of metal rivets whose shank and under-the-head surfaces are covered with a uniformly thick plastic insulation. They have flat heads and semi-tubular shanks. They are available in aluminum, brass, steel and other metals. Nylon insulation is standard; other materials can be supplied. The plastic insulation extends slightly beyond the end of the metal rivet.

The new rivets are generally used in

CONTINUED ON PAGE 214



MAKE IT WEIGH LESS

N·A·X

HIGH-TENSILE STEEL

MAKE IT LAST LONGER

You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

NATIONAL STEEL CORPORATION

electrical applications where it is necessary to fasten two or more electrical conductors to a common insulated base and yet not have the conductors connected to each other electrically. Other applications include riveting to ceramic or glass where the plastic sheath acts as a shock-absorber, for air-tight or water-tight joints and in similar applications. A variety of lengths and diameters are now in production and other sizes will become available as required. Pylon Co., P. O. Box 55, Attleboro, Mass.

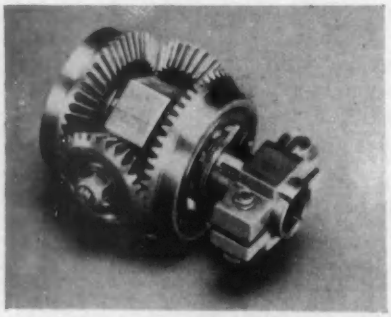
For more information—
Circle 8, inside back cover

Hollow Lock Screws

This lock screw is made of heat-treated alloy steel. "Through" design of the hex socket permits adjustment or resetting of the set screw without removal of the lock screw. When in place, the lock screw presses against the upper surface of the set screw, providing extra locking action.

These new fastenings are produced with coarse or fine threads in twelve standard diameters ranging from No. 6 to 1 in. The length of the screw is $\frac{1}{8}$ in. for sizes No. 6, 8, 10 and $\frac{1}{4}$ in. Larger screws are $\frac{1}{2}$ in. length. Class 3 fit is standard. Strong, Carlisle & Hammond Co., 1392 W 3 St., Cleveland 13, Ohio.

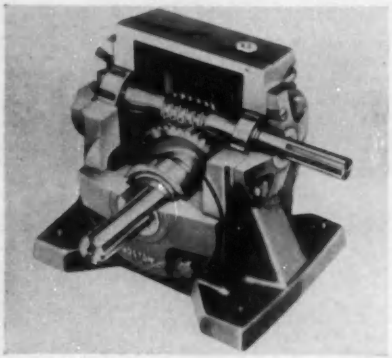
For more information—
Circle 9, inside back cover



Hollow Shaft Differential

A simple shaft lock provides for removal of the differential from a gear train without disassembly of the end plates. Available for shaft sizes of 0.062, 0.125, 0.187, and 0.250 in. The corresponding clearance circles are 0.006, 0.750, 1.000 and 1.187 in., all differentials have precision ball bearings throughout and are constructed of stainless steel. Sterling Precision Instrument Corp., 34-17 Lawrence St., Flushing 54, N. Y.

For more information—
Circle 10, inside back cover



Speed Reducers With Ratings of 40 to 900 Lb.-in.

Fins on the housings of these reducers improve heat dissipation. Fan-cooling is optional on larger sizes, except compound units. Listed outputs are certified by independent laboratory tests.

These new reducers are available in 52 standard stock models: 283 different units with ratios from 5:1 to 3600:1. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

For more information—
Circle 11, inside back cover

Double-Enveloping Worm Gear Speed Reducers

This line of motorized reducers includes both standard extended shaft and the recently introduced shaft-mounted models with worm over, under or vertical. They can be ordered with or without motors, since the motor bell-housing adapter will accommodate standard NEMA C-type flanged motors.

Pulleys, sheaves, belts, bearings, torque arms or motor bed plates are not required. The complete unit is simply coupled to the shaft to be driven, or on the shaft if a shaft-mounted model is specified. All motorized models can be wall, ceiling or floor-mounted in any position desired. These motorized models include 2, $2\frac{1}{2}$ and 3-in. center distance units. Reduction ratios range from 5:1 to 60:1. Load capacities range from fractional to 9 hp. Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich.

For more information—
Circle 12, inside back cover

Motorized Speed Reducers

Combination construction is asserted to permit removal of motor at any time without disturbing the gear reduction unit. Also, the original motor may be easily replaced with one of special characteristics (totally enclosed, explosion-proof). These units are also available without motor as flanged reducers. A range of 28 standard stock models are available. Thirteen different sizes, from $\frac{1}{6}$ to 10 hp are made, with various voltages.

The flanged reducers are available in the same range, with ratios from 10:1 to 3600:1, and output torque ratings from 50 to 9400 lb-in. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

For more information—
Circle 13, inside back cover

Direct In-Line Drive

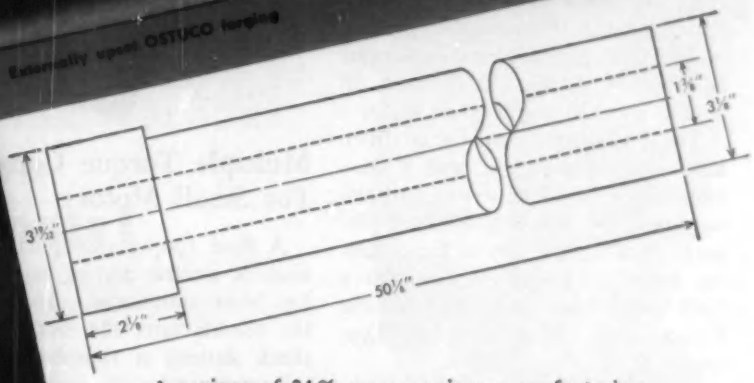
To couple opposing shafts is this direct in-line clutch's primary function. A universal joint is provided for ease of coupling alignment and opera-

CONTINUED ON PAGE 216

Externally Upset OSTUCO Tubing

saves 31% on processing improves mandrel life

for Halliburton Oil Well Cementing Company



A savings of 31% over previous manufacturing methods, was made possible by using externally upset OSTUCO Tubing as Wall Packer Mandrels in "Howco" Expanding Shoe Assemblies. These OSTUCO forgings eliminated a welding operation and reduced machining time and cost. One-piece fabrication greatly improved the useful life of the part.

Compare your tubing costs with job-designed OSTUCO Tubing. *Special-quality* OSTUCO Tubing is manufactured to your individual requirements . . . formed to save processing time and waste. Fill all your tubing requirements on *one* order with OSTUCO'S unique *single-source* service. You'll eliminate interplant shipment, reduce error and speed delivery. Wire, write or phone OSTUCO for complete details, or submit blueprints for immediate quotation.

OSTUCO SHELBY, OHIO

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING
—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
Birthplace of the Seamless Steel Tube Industry in America
SALES OFFICES: BIRMINGHAM • CHARLOTTE • CHICAGO (Oak Park) • CLEVELAND • DAYTON • DENVER • DETROIT (Ferndale) • HOUSTON • LOS ANGELES (Beverly Hills) LOUISVILLE • MOLINE • NEW YORK • NORTH KANSAS CITY PHILADELPHIA • PITTSBURGH • RICHMOND • ROCHESTER ST. LOUIS • ST. PAUL • SEATTLE • TULSA • WICHITA
CANADA, RAILWAY & POWER ENGR. CORP., LTD.
EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
117 Liberty Street, New York 6, New York

tion. The assembly weighs approximately 1 oz, can be supplied to operate from 6 to 30v, dc, or rectified ac (6 and 28 v from stock), with under 1 w power consumption. Clutch transmits from less than 1 oz-in. to over 15 oz-in. from engagement to disengagement. It is advisable to apply to speeds not above 200 rpm. EMEC, Inc., 2410 Beacon Ave., Seattle, Wash.

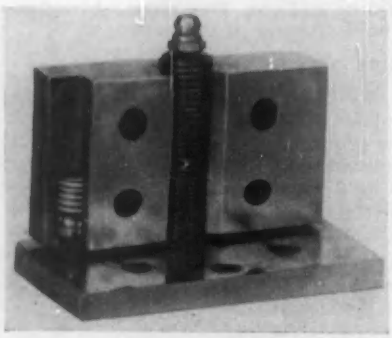
For more information—
Circle 14, inside back cover

Instrument Spur Gears

Pin hub-type spur gears are immediately available from stock in Type 303 stainless steel, clear passivated, or 24ST aluminum chromic acid anodized (before cutting). Cut to AGMA Precision 1 tolerances, gears are stocked in 48, 64, 72 and 96 pitches with 20 deg pressure angle.

These gears are available in three basic shaft sizes—$\frac{1}{8}$, $\frac{5}{16}$ and $\frac{1}{4}$ in.—with stainless steel set screws for holding, and a sub-drill hole for fixed pinning. Face widths vary in the following steps—$\frac{3}{32}$, $\frac{1}{8}$ and $\frac{3}{16}$ in., with a tooth range from 20 up to 150. Pic Design Corp., 160 Atlantic Ave., Lynbrook, N. Y.

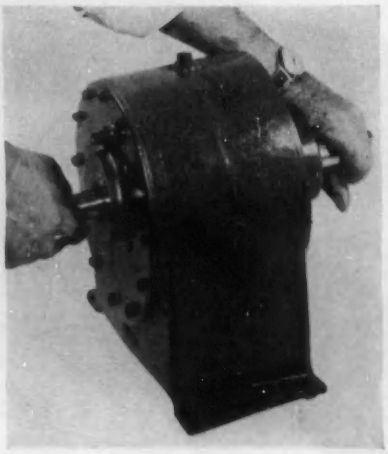
For more information—
Circle 15, inside back cover



Pressure-Lubricated Hinge

This hinge is said to be silent and sagproof. It was designed for access doors on vehicles such as petroleum trucks, and is installed by welding or bolting to door and frame. Its threaded pivot bearing harbors grease and eliminates end play. A spring-loaded ball detent holds door in any one of three positions. Betts Machine Co., 1800 Pennsylvania Ave. W., Warren, Pa.

For more information—
Circle 16, inside back cover



Multiple Torque Converter For Small Motors

A fluid torque multiplier for gasoline or electric motors under 10 hp has been announced. According to the manufacturer the unit eliminates shock starting or stopping and gives full power take-offs on intermittent or power loading. The unit is completely self contained and consists of a turbine, reaction member and pump in an aluminum housing. Total weight of this new multiple torque converter is 27½ lb. Little Beaver Industries, Willoughby, Ohio.

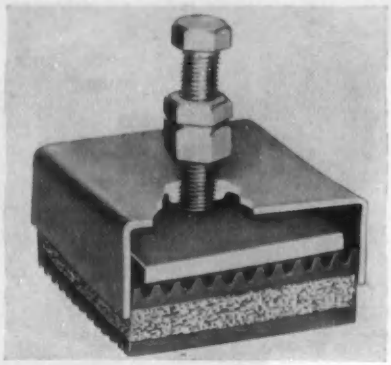
For more information—
Circle 17, inside back cover

Gusher Pump for Machine Tools

This pump is arranged for center coolant trough mounting on traveling base machine tool installations. The tapered tubular housing is provided with a reinforced narrow section for passage through the limited width slot in the trough cover.

A one-piece electronically balanced shaft assembly rotates on two heavy-duty precision ball bearings, one of which is located within the top motor-and-ball housing and the other in the tubular portion of the bracket flange housing. Like all gusher pumps, this one has no packing glands nor metal-to-metal contacts below the liquid high level line. The built-in electric motor used in this new pump is available in ½, ¾ and 1 hp sizes. Ruthman Machinery Co., 1810 Reading Road, Cincinnati, Ohio.

For more information—
Circle 18, inside back cover



Vibration Damper

An adjustable leveling mount that requires no anchor bolts and shims has a core of cork plate bonded between two layers of neoprene. The damper is available in a range of sizes to accommodate a variety of loading conditions. It provides for a maximum of $\frac{5}{8}$ in. height adjustment. Korfund Co., Inc., 48-19G 32nd Pl., Long Island City, N. Y.

For more information—
Circle 19, inside back cover

Pneumatic-Tired Casters

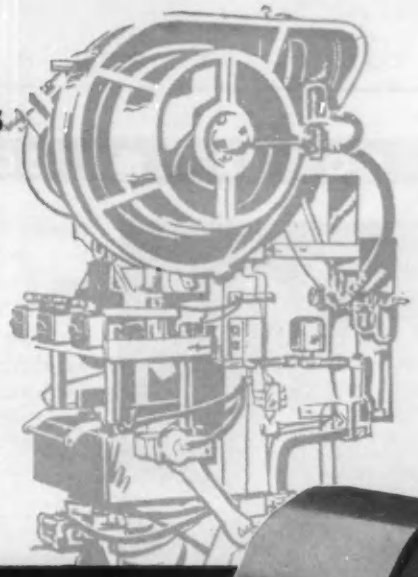
Wheels are equipped with roller bearings. The casters are available in both rigid and swivel models, with a choice of three wheel sizes in each model. Tires are four-ply, with separate inner tubes. Tire sizes are: 8x3.00/4, 10x3.50/4, and 12x4.00/6. Hamilton Caster & Manufacturing Company, 1700 Dixie Highway, Hamilton, Ohio.

For more information—
Circle 20, inside back cover

CONTINUED ON PAGE 218

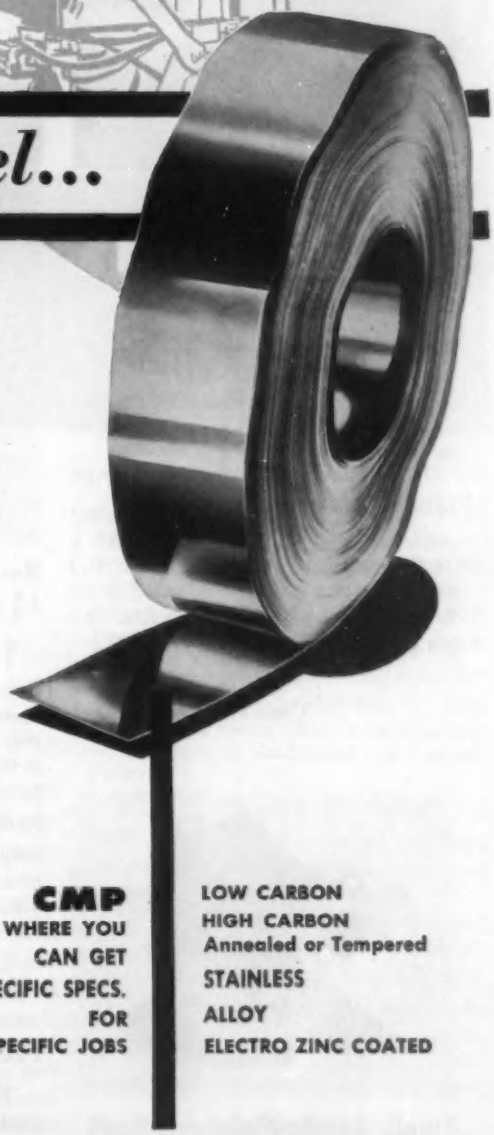
LIKE REVOLUTIONARY COST CUTTING PRESSES

that operate with near-human dexterity, superhuman accuracy, speed and endurance and minimum human effort and attention to produce better products faster and more economically . . .



CMP

cold rolled strip steel...



can help reduce your manual costs!

CMP's precision processing methods hold oversize width and gauge variations within exceedingly close limits (even as fine as 5" ± .003" x .067" ± .001" if required), resulting in . . .

. . . top parts yield per ton . . . more feet per coil . . . fewer production interruptions for coil replacement on automatic feed operations.

. . . less wear on dies . . . fewer die changes and "regrinds."

. . . easier fitting and assembly . . . fewer "oversize" rejects . . . less tedious "resizing" to make oversize parts fit.

More important . . . in many cases, CMP Cold Rolled Strip Steel can be processed to restricted physical specifications to facilitate, consolidate or even eliminate labor-consuming production operations and handling. Often, a simple specification change can do as much or more to reduce manual costs than expensive new equipment.

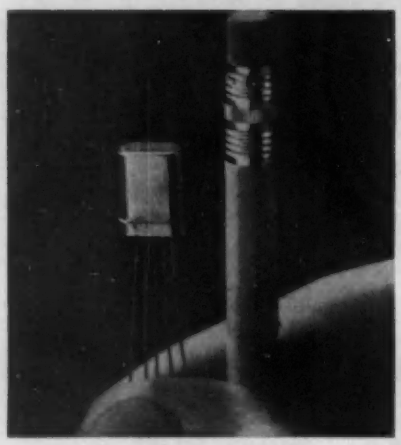
A qualified CMP representative will be pleased to check your flat-rolled material specifications and fabricating processes with a view to developing restricted specifications that will cut your end-product costs.

CMP
WHERE YOU CAN GET SPECIFIC SPECS. FOR SPECIFIC JOBS

LOW CARBON
HIGH CARBON
Annealed or Tempered
STAINLESS
ALLOY
ELECTRO ZINC COATED

the Cold Metal Products co.
GENERAL OFFICES: YOUNGSTOWN 1, OHIO
PLANTS. YOUNGSTOWN, OHIO AND INDIANAPOLIS, INDIANA
SALES OFFICES: New York • Cleveland • Detroit • Indianapolis
Chicago • St. Louis • Los Angeles • San Francisco

POWER AND CONTROL

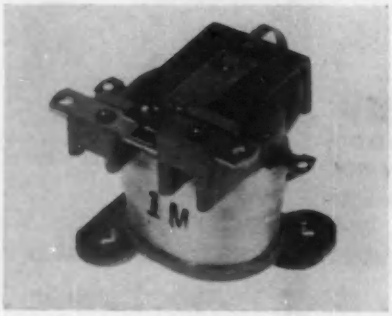


Shock-Resistant Relay 1/2 In. High

This relay is designed specifically for applications in which capacity, weight, size and reliability are of extreme importance. It is capable of withstanding severe shock and vibration, together with violent extremes in temperature.

It is a single-pole, double-throw relay weighing 0.035 oz. It has a ¼ amp contact rating (non-inductive) and a 26.5-v d-c rating. Its sensitivity is 100 milliwatts and it can be adjusted down to approximately 40 milliwatts. Elgin-Neomatic, Inc., Elgin, Ill.

For more information—
Circle 21, inside back cover



Small Single-Pole, Double-Throw Relay

This relay is said to have been designed for use in such devices as automatic headlight dimmers, radiosondes, radio controlled toys. Tentative specifications of the Type 11F are: 50 milliwatt to operate (24 ma in 9000 ohm coil); 1 amp max contact load; up to 9000 ohm coil resistance; 1 13/32 x 1 7/16 x 1 in. Weight is 1 oz. Sigma Instruments, Inc., 81 Pearl St., S. Braintree, Boston 85, Mass.

For more information—
Circle 22, inside back cover

Rechargeable Battery 1⅛ In. High

This 1/10 amp-hr battery could operate an electric wristwatch for more than a year before requiring recharging, according to its maker. It weighs ⅛ oz. Based on the silver-zinc design principle, the battery provides maximum continuous drains of 500 milliamperes and peak pulse currents in excess of 2 amp. Yardney Electric Co., 40 Leonard St., New York, N. Y.

For more information—
Circle 23, inside back cover

Frequency Sensitive Relays

These relays are now available in enclosures little larger than a package of cigarettes. They are available in either crimp-cover or hermetically sealed types weighing 12 oz. Applications include under and over frequency cut-off for 400 or 60-cycle equipment, under and over frequency light indicators, automatic synchronizing, sequence control for turbo starting, circuit breaker or transfer switch operation at exact frequency, engine overspeed. They are said to be unaffected by vibration, shock, humidity or altitude, and as there are no electronic components or moving parts, except at moment of operation, they will hold their calibration indefinitely.

The frequency sensor consists of a tuned vibrating reed driven by an electro magnet connected to the frequency reference which can be a 400 or 60-cycle alternator or tachometer generator. When the reference frequency resonates with the fundamental mechanical frequency of the reed, the latter vibrates and closes contacts to pull in a control relay. The energy required for operation of the reed is less than 1 w and the resonate frequency can be calibrated to 1 per cent.

Standard models are furnished with single-pole, double-throw contacts to open a circuit or close it as required at the pre-set frequency point, and can be secured for either automatic or manual reset. The industrial model is sealed against dust and splash, but for explosionproof or airborne applications the hermetically sealed type is recommended. Custom Built Controls, 661 Delaware St., Denver 4, Colo.

For more information—
Circle 24, inside back cover

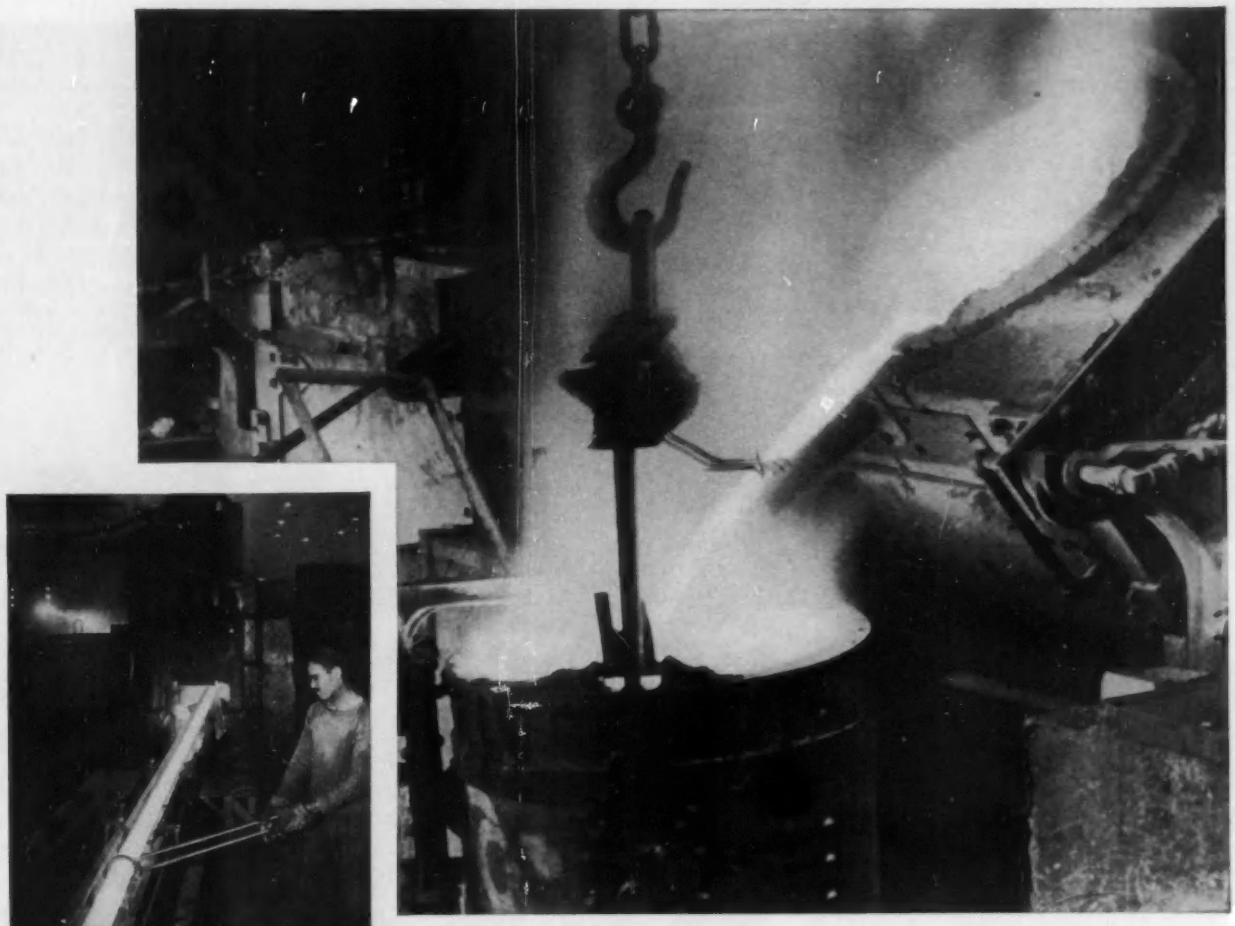
Gasket-Mounted Pressure Switch

A pressure switch for hydraulic presses, production and processing machinery, machine tools and other similar oil-hydraulic equipment has a special sub-plate available for mounting where a machined pad is not provided.

Three models for three pressure ranges cover from 100 to 1000 psi, 100 to 2000 psi and 500 to 5000 psi. Pressure settings are adjustable throughout the complete pressure range of each model.

Overall dimensions are identical, 3 7/8

CONTINUED ON PAGE 220



Comes in seamless tubing, pipe and extruded tubing — as well as other standard wrought mill forms.

Now comes NIONEL

New Inco Nickel Alloy to withstand hot acids and oxidizing chemicals

H_2SO_4

H_3PO_4

H_2SO_3

HNO_3

many more

Have you heard about Nionel?

It's Inco's new nickel-chromium alloy, containing molybdenum and copper, designed to withstand corrosive conditions of unusual severity.

Nionel brings you outstanding resistance to certain hot acids — sulfuric, sulfurous, nitric and phosphoric acids. It resists such oxidizing chemicals as nitrates and cupric, ferric and mercuric salts (except chlorides). It is highly resistant to most organic acids as well as to general corrosion, pitting and stress-corrosion cracking by sea water and other chloride-containing waters.

Where can Nionel be used? To handle sulfuric acid in many chemical processes and in petroleum refineries, detergent plants, rayon production and ore treatment. To handle sulfurous gases and condensates and pulp digester cooking liquors. In equipment for phosphoric acid production. In heat exchangers using chloride-containing cooling waters. And many other applications.

What forms are available? All standard mill forms, including plate, seamless condenser tubing, pipe and extruded tubing.

In Nionel you have an important new ally in the battle against difficult corrosive conditions. So learn all about it. The new booklet "Introduction to Nionel" describes composition, physical and chemical properties, suggested applications. Write for your free copy.

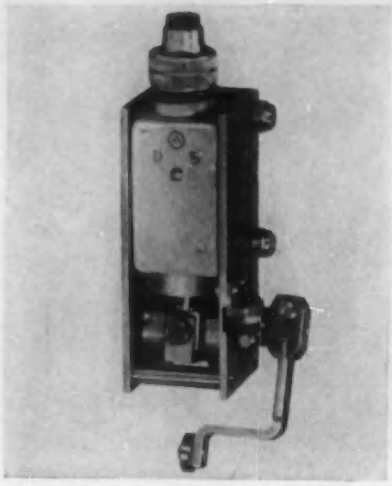
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys**

Nionel ... *for strong corrosives*

in. wide x 7¼ in. long x 2 in. deep. Nominal current ratings are 10 amperes at 110-125 v, ac, for the 100 to 1000 psi size, 5 amp at 220-250 v, ac, for the 100 to 2000 psi and 3 amp at 440-460 v, ac, for the 500 to 5000 psi. Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.

For more information—
Circle 25, inside back cover



Hermetically Sealed Rotary Actuator Switch

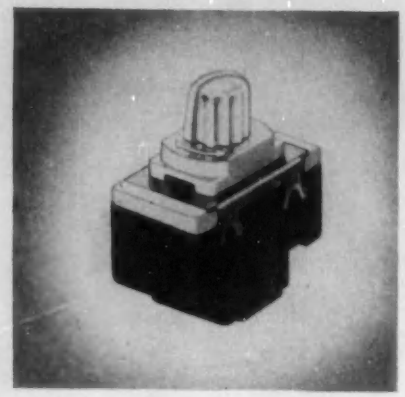
The actuator arm has optional settings throughout 360 deg with operating travel of 90 deg. The long overtravel of 81 deg. protects the basic hermetic switch and also permits flexibility of application. The actuating force of 20 lb is said to assure positive operation and "break-through" of any ice formations on the switch.

With an extreme life span of 200,000 cycles, switch is rated for 10 amp at 125/250 v, ac, 28v, dc, inductive and 10 amp at 28v, dc, resistive. Ambient temperature range is −100 F to plus 250 F. Weight is 0.06 lb. Electro-Snap Switch & Mfg. Co., 4218 W. Lake St., Chicago 24, Ill.

For more information—
Circle 26, inside back cover

Quiet Switches That Glow

Exposure to any light source enables this switch's luminous knob to pin-point switch location. For use on



a-c circuits, these switches can be used to full current rating on fluorescent and incandescent lighting loads and on motors when the full load current is not more than 80 per cent of rating of switch.

Available in models for combination wiring or the conventional strap type, these switches are rated 15 amp, 120 v, ac, 277 v, ac. Strap type is rated at 15 amp, 120 v, ac. Pass & Seymour, Inc., Syracuse 9, N. Y.

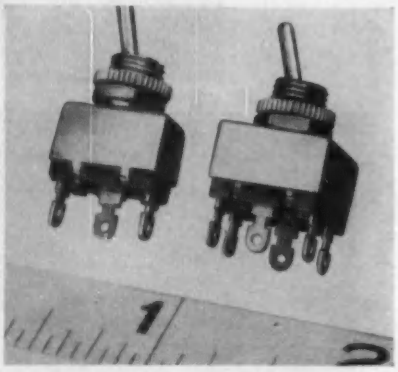
For more information—
Circle 27, inside back cover

Foot Switch 1⅛ x 3⅝ In.

This switch is housed in a steel case with an unbreakable plastic cap. A non-skid sponge rubber base is provided.

The slightest foot pressure from any angle on the actuating cap operates the switch. It is furnished with a heavy duty 6-ft black rubber cord set with a series plug and molded strain relief grommet. Linemaster Switch Corp., 432 Woodstock Terr., Woodstock, Conn.

For more information—
Circle 28, inside back cover



Switches Rated at 10 Amp

Two subminiature toggle switches are both double-throw, and are available in single-pole and double-pole types. They are contact rated for 10 amp at 50 v, dc, and weigh 0.15 oz and 0.22 oz, respectively.

Dimensions, including terminals and handle are 0.25 x 0.5 x 1.047 in. for the single pole, and 0.5 x 0.5 x 1.047 in. for the double-pole. Both switches conform to electrical and environmental requirements of JAN S-23 Amendment 3. Torsion Balance Co., Clifton, N. J.

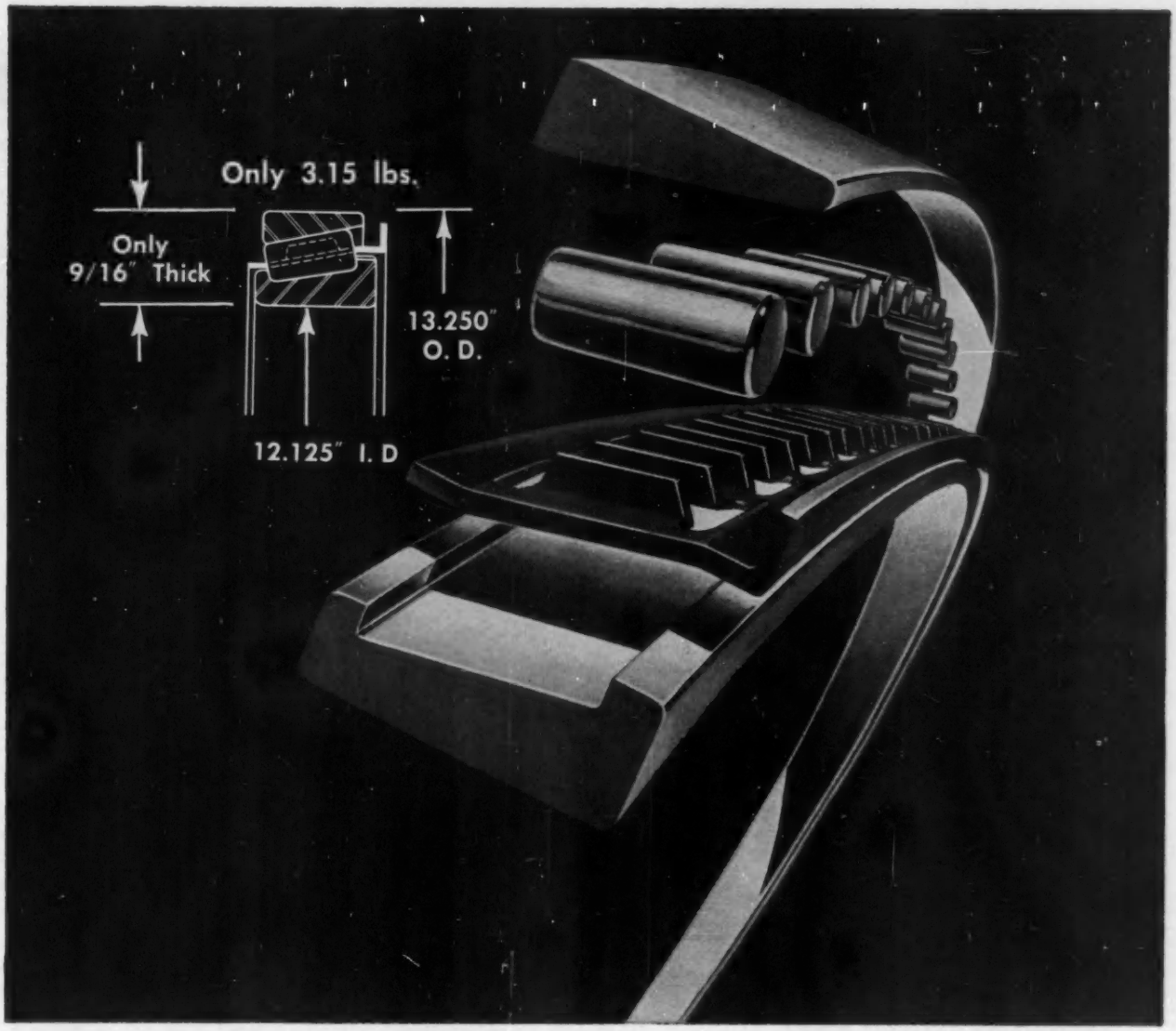
For more information—
Circle 29, inside back cover

Fhp Motor With Ribbed Base

This line of motors has ribbed bases, designed to withstand more abuse than conventional types. Widely spaced contact points are said to provide maximum rigidity and minimize pivoting effect. An 11-gage steel frame and Mylar insulation in stator slots are provided. The centrifugal type starting switch was tested through more than 6 million cycles according to the manufacturer.

The motor conforms to NEMA standards for "56" frame motors. It

CONTINUED ON PAGE 222



Kaydon...
world's thinnest tapered roller bearings

Reali-Slim — that's the name we've given our line of extremely thin-section, lightweight bearings. The bearing shown above is a *Reali-Slim*. *Reali-Slim* bearings are really strong, too! The single row, tapered roller bearing we're talking about, here, has a 33,000-lb. radial capacity—with 38,200-lb. thrust capacity. Over 1-ft. in diameter, yet it weighs only 3.15 lbs! These figures tell how *Reali-Slim* bearings combine minimum section with high strength and long life.

If you're looking for a whole new concept in thin-section, lightweight bearing design — look at Kaydon's *Reali-Slim* line. In addition to hundreds of *Reali-Slim* standard sizes, there's a big variety of special races and separators to meet special applications. Kaydon engineers are prepared to give you valuable help with your application problems.

For more information write Kaydon of Muskegon. Ask for engineering Catalog No. 54-RS detailing:

★ ***Reali-Slim Ball Bearings*** — in Conrad, angular contact and 4-point contact types are available in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40.000".

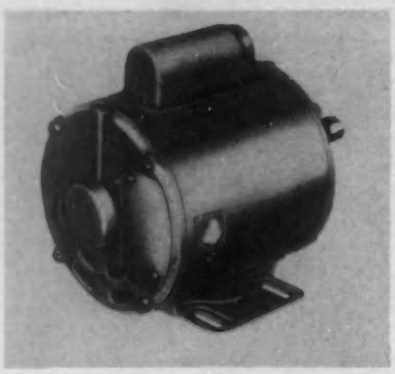
★ ***Reali-Slim Roller Bearings*** — in radial and taper roller types are available in cross sections from 9/16" and in bore diameters from 5" to 40.000".

K-552

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" to 120" outside diameter . . .
Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings.



is available in three basic types; split-phase, capacitor-start and polyphase, and in ratings ranging from ¼ to 1 hp. Hoover Co., Electric Motor Div., 68 Brook Avenue, N. Plainfield, N. J.

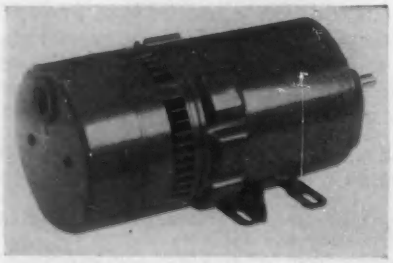
For more information—
Circle 30, inside back cover

Miniaturized Rotary Selector Switch

Slightly larger than a penny in diameter, this switch is available in single-pole (up to twelve positions), two-pole (six positions), three-pole (four positions) and four-pole (three positions). Mounting is the same as that for the usual volume control, with standard ⅜ in. bushing and ¼ in. shaft.

The new switch measures ¾x1⅛ in. over-all. Current ratings are 50 ma at 300 v, ac or dc, 500 ma at 30 v. Clarostat Mfg. Co., Inc., Dover, N. H.

For more information—
Circle 31, inside back cover



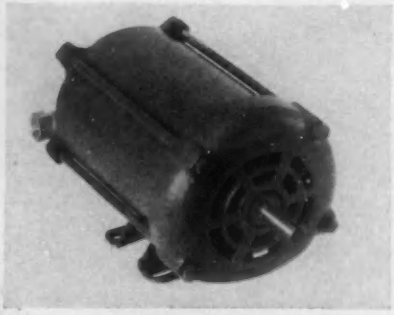
Fhp Brake Motor

The brake has been redesigned to fit a new small-size Form G motor. A combined manual release and wear indicator is recessed in the brake housing. A large finger recess permits manual release even by a workman wearing gloves.

According to the maker, the type of brake lining used makes adjustment virtually unnecessary for the life of the brake on most applications. However, when it is required, adjustment can be made easily without special tools.

The magnetic brake is spring-set and solenoid-released. In the event of a power failure, it automatically sets, giving added protection. The new brakemotors are available in ¼, ⅓, ½ and ¾ hp ratings, at 1725 rpm. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 32, inside back cover



Reversible Electric Motor

This motor measures 2x2x2 in. and has a torque rating of 5 lb-in. at 1 rpm. It is designed to operate on 115-v, 60-cycle current. Speed range is from 10 rev per hr to 1800 rpm. Bristol Motor Div., Vocaline Co. of America, Inc., Old Saybrook, Conn.

For more information—
Circle 33, inside back cover

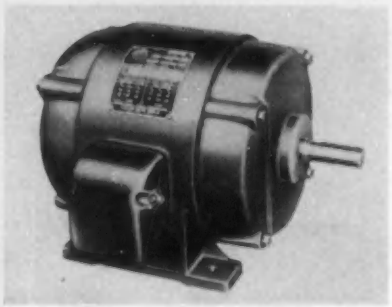
Explosionproof Fhp Motor

For operation in hazardous atmospheres such as dry-cleaning plants, paint factories and gasoline refineries, this motor is constructed with heavy cast iron end shields. Overbolt construction is said to give the motor assembly additional strength with little increase in weight.

According to the maker, the new motor will give 10 yr normal service without relubrication. Use of a new ball-bearing grease, which is highly resistant to oxidation and moisture, makes this possible.

The motor has been UL-tested and approved for Class I, Group D; and Class II, Groups E, F and G atmospheres. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 34, inside back cover



A-c Motors Up to 30 Hp

These motors are built to the new NEMA standards. They have a lower air opening in the end-bell combined with a steel baffle plate, giving maximum protection to the winding from moisture and abrasive dusts in the dripproof design. Double-end ventilation is provided by dual cast aluminum fans. Currently, all standard ratings are available in frame sizes 182, 184, 213 and 215. The balance of the line will go up to and include 30 hp models. Lima Electric Motor Co., 131 Findlay Road, Lima, Ohio.

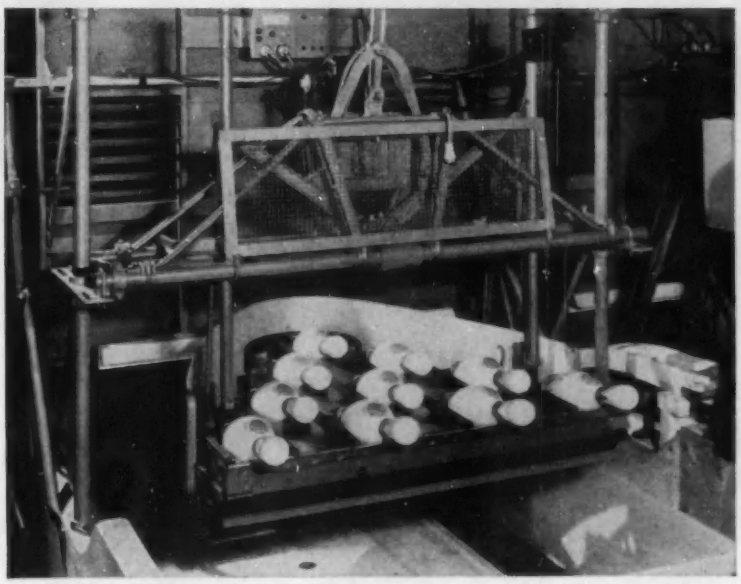
For more information—
Circle 35, inside back cover

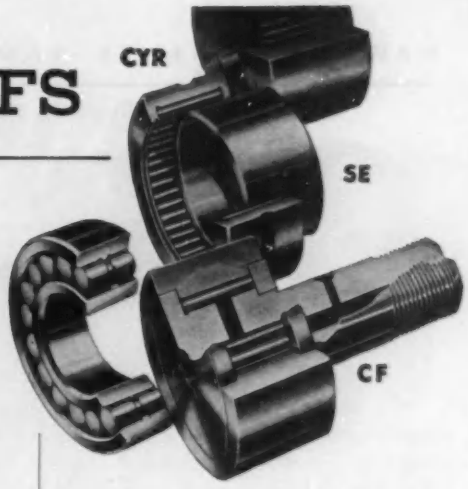
Close-Coupled Pump Motor

Designed specifically for use with centrifugal pumps operating in dangerous, damp or dusty locations, these totally enclosed motors are available in models ranging from 1½ to 25 hp. The larger ratings are double-enclosed and fan ventilated for rapid heat dissipation. Smaller ratings are self-cooled by radiation. They are fitted with a specially sealed conduit box, elongated bearing sleeves, sparkproof aluminum fan and long bracket registers. The complete new line of pump motors

CONTINUED ON PAGE 224

McGILL BEARING BRIEFS





CAMROL CF bearings ADD TO SAFETY of 22,000 Brunswick-Balke-Collender semi-automatic pinsetters now in use

When the pinboys "set 'em up in the other alley" a McGill CAMROL Cam Follower helps them do the job without danger to themselves or damage to the pin-setting machine.

Known as the B-10 Semi-Automatic Pinsetter, this machine is a product of The Brunswick-Balke-Collender Company and is in use on 22,000 individual bowling lanes throughout the world.

In these machines the CAMROL CF bearing is used in the safety latch mechanism to lock the cam action and prevent the machine from recycling during pin setting. Used by the company for 4 years, the CAMROL bearing has given no trouble despite the literally millions of cycles these 22,000 machines have been operated.

CAMROL Cam Follower bearings utilize a full complement of small diameter followers with outer race and integral stud and flange custom heat treated for the ultimate in radial and shock load capacity.

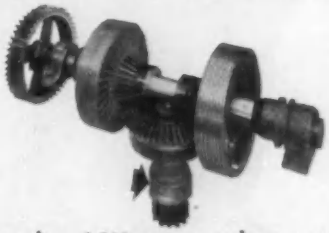
Precision tolerances on all grinding surfaces with simplified lubrication minimizes internal wear and increases bearing life. Both starting and running friction are reduced to a minimum.

McGill designed and built the first Cam Follower and used 20 years of experience with thousands of applications to perfect the right Cam Follower for any cam action application.

BEARING SELECTION GUIDE

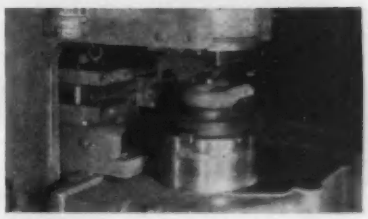
A revised 140 page Bearing Selection Guide, complete with 30 pages of vital engineering data, has been released by the McGill Manufacturing Co. Ask for Catalog No. 52.

CAMROL CF BEARING USED from BEGINNING of PRODUCTION by SCHIELD-BANTAM COMPANY



More than 5,500 cranes and excavators built by Schield Bantam since 1945 use CAMROL CF Bearings in SHIFTING COLLAR vertical swing shafts and drum clutch applications. With maintenance negligible and performance excellent the manufacturer asserts, "Using CAMROL CF Bearings offers an overall price advantage and insures maximum product quality."

PINES PRESSURE DIE HOLDER PUTS up to 18,000 POUND LOAD on CAMROL CYR BEARING



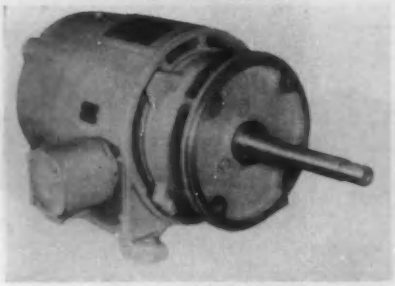
Pines Engineering Co., Inc., has used the CAMROL CYR Bearing for 6 years in tube bending machines and has never had a failure. The bearing takes the full bending moment in Pines pressure die holders that bend extra heavy pipe in sizes ranging from ¾" to 4" without scratching the tubing.

50th Anniversary

McGILL design leadership has given you these important developments

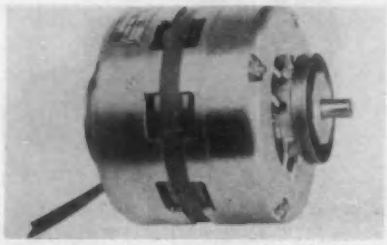
★ First full type roller bearing ★ First guided full-type roller bearing ★ First Cam Follower roller bearing ★ First sealed roller bearing

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA



has asbestos-protected windings, normalized castings and cast rotor. U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 36, inside back cover



Induction Motors of 1/8 to 1/100 Hp

A motor with a distributed type winding, designed for business machines, dictating machines, facsimile equipment, tape recorders and other commercial and military applications, made with a die-cast zinc housing. The motor is available in two, four, six, eight and twelve-pole versions, single and dual speed combinations in standard induction and synchronous types. Howard Industries, Inc., Racine, Wis.

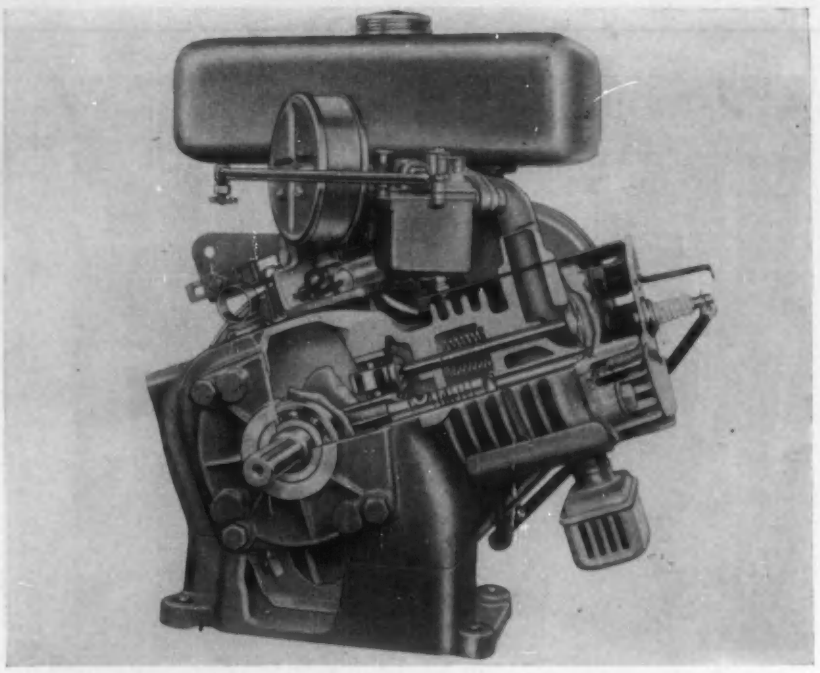
For more information—
Circle 37, inside back cover

Instantly Reversible Fhp Motors

The motor has a large, built-in, five-stud terminal board with reversing connection diagram on inside of terminal box cover. The external switch can be thrown from one polarity to the other as rapidly as is mechanically possible. A high voltage capacitor helps start and reverse heavy loads.

Sizes are $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$ and $\frac{3}{4}$ hp. The motors are available in 115 or 230-v, single voltage ratings. All of these new reversible motors operate at 60 cycles, 1725 rpm. General Electric Co., Schenectady 5, N. Y.

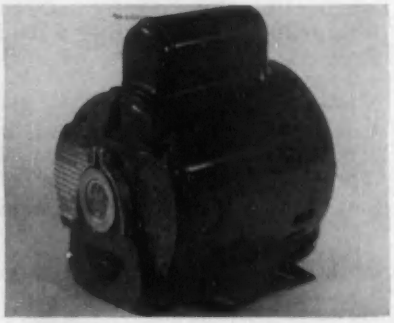
For more information—
Circle 39, inside back cover

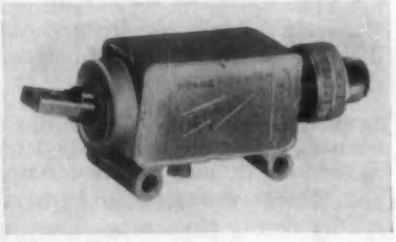


Air-Cooled 3 Hp Gas Engine

A series of heavy-duty air-cooled engines now in production includes a 3-h.p. model that is $13\frac{1}{8}$ in. high. A center-bowl type carburetor permits engine operation at extreme tilt angles. A larger-diameter intake valve and higher cooling capacity are provided. Continental Motors Corporation, 12800 Kercheval Avenue, Detroit 15, Michigan.

For more information—
Circle 38, inside back cover





Ice-Proof Switch

This hermetically sealed switch will reset even when coated with ice. A variation of actuators is available, including roller, leaf, cam and others.

The new switch is rated at 10 amp for 125/250 v, ac, 28 v, dc, inductive and 28 v, dc, resistive. Electro-Snap Switch & Mfg. Co., 4218 W. Lake St., Chicago 24, Ill.

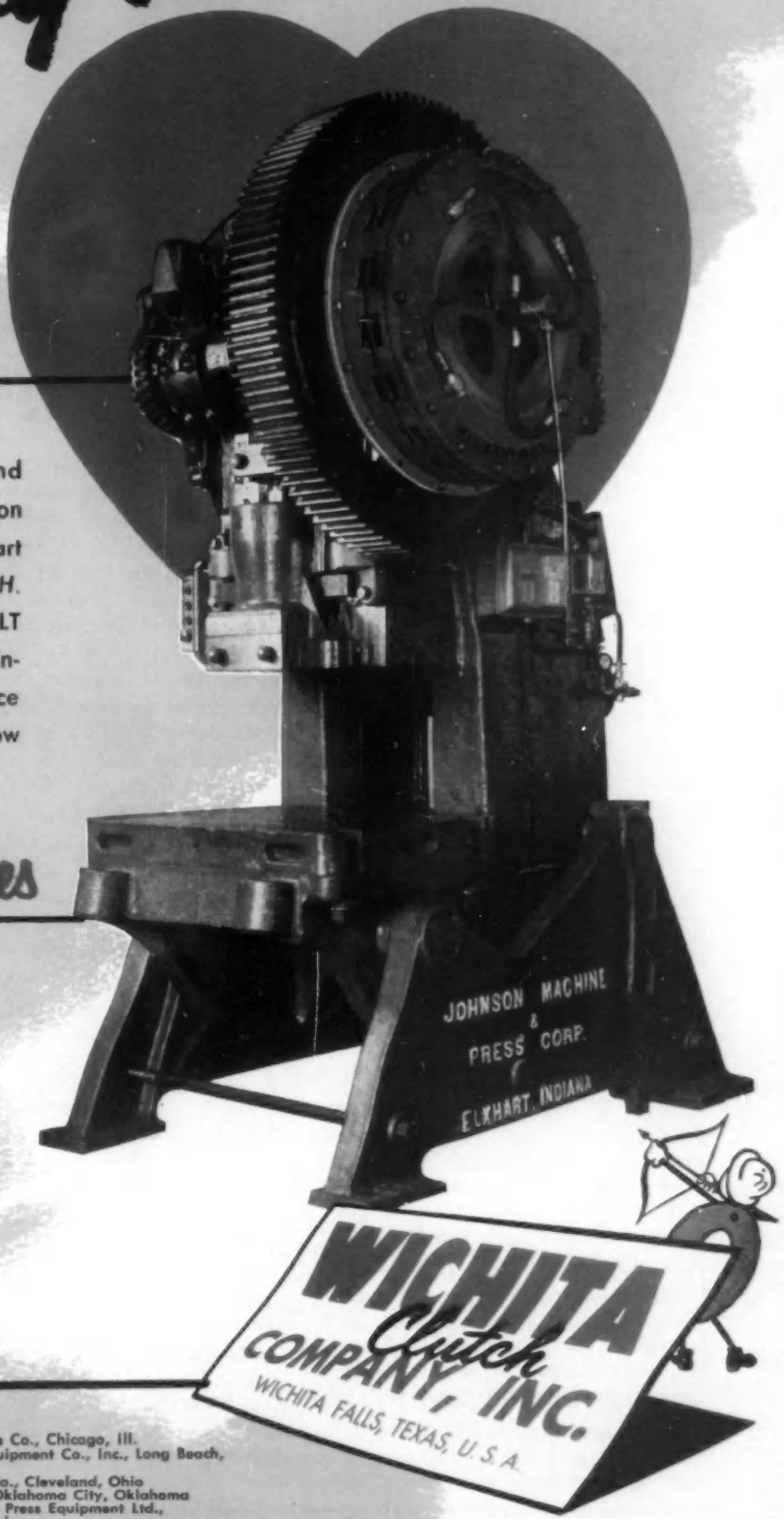
For more information—
Circle 40, inside back cover

CONTINUED ON PAGE 226

A Strong Heart...

it's a

WICHITA
LOW INERTIA
Air-Tube CLUTCH



For smoother, faster, more consistent and trouble-free operation, this Johnson 90-ton OBI press was equipped with a Strong Heart ...*The WICHITA Low Inertia Air-Tube CLUTCH.* This clutch is compact, powerful, and BUILT FOR YEARS OF SERVICE. Make your machinery more efficient with increased performance and production by changing to Wichita Low Inertia Air-Tube Clutches...NOW!

Additional Advantages

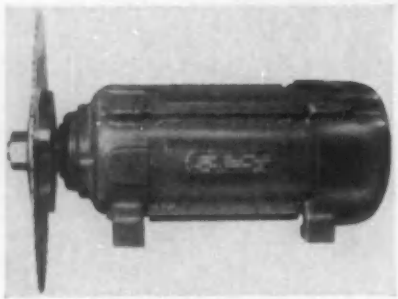
SAFER OPERATION
COOLER RUNNING
MINIMUM SLIPPAGE
NO LUBRICATION
NO ADJUSTMENTS
NO BACKLASH
BUILT IN STANDARD & LOW INERTIA TYPES
(ALL POSITIVELY VENTILATED)

FOR COMPLETE INFORMATION, CALL THE WICHITA ENGINEER NEAREST YOU

WICHITA DISTRIBUTORS

Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., (Main Office) Avon, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, N. Y.
Frank W. Yarline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Robert R. King Co., Cleveland, Ohio
John C. Burge, Oklahoma City, Oklahoma
Dominion Power Press Equipment Ltd., Toronto, Canada

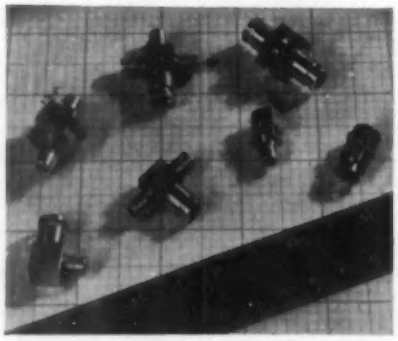
11 DN



Dustproof Motor Arbor

These arbors are designed for woodworking equipment and are available with standard saw-flanges and nut or with special arbor extensions machined as required up to a maximum diameter of 2 in. They are offered in ratings from 2 to 7½ hp at 3600 rpm, 3¼ in. from center line to top or side. Imperial Electric Co., 64 Ira Ave., Akron, Ohio.

For more information—
Circle 41, inside back cover

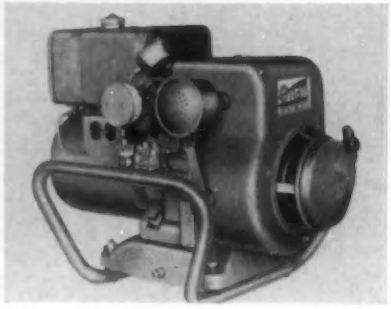


Lightweight Miniature Connectors

Designed for use in fuel quantity gaging and fuel management systems, these connectors are said to be impervious to moisture and will maintain a minimum shell-to-conductor resistance of 100 megohm even after prolonged immersion in salt water.

In addition to plugs and jacks, types available include crosses, tees, right angles and pressurized bulkhead feedthroughs. Specialized units, such as hermetically sealed types and friction disconnects, are also available. Units will accommodate shielded wire sizes from 0.070 to 0.150 in. OD and unshielded wire from 0.060 to 0.130 in. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y.

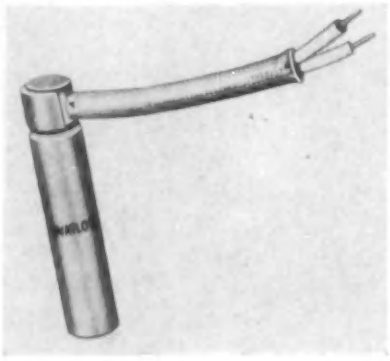
For more information—
Circle 42, inside back cover



Small Engine-Driven Electric Plants

A line of small engine-driven electric generating plants is available in sizes of 500 and 750 w, 60 cycle, ac, in the AK Series and in 1000 and 2,500 w, 60 cycle ac, in the AJ Series. Battery charging units are available in sizes ranging from 500 to 1500 w, dc. Powered by an air-cooled, four-cycle, single-cylinder gasoline engine, the AK models deliver 1.85 hp at 1800 rpm, the AJ models, 2.75 hp at 1800 rpm and 5 hp at 3600 rpm. D. W. Onan & Sons Inc., Minneapolis, Minn.

For more information—
Circle 43, inside back cover



Right-Angle Cartridge Unit

The leads emerge from the ceramic head of this cartridge at right angles, eliminating stress on the leads wherever the wiring plan requires that they make a full 90 deg turn at or near the head of the cartridge unit. The leads are said to require less installation space on the longitudinal dimension. The new design is available in ⅜ and ½ in. dia. Watlow Electric Mfg. Co., 1372 Ferguson Ave., St. Louis 14, Mo.

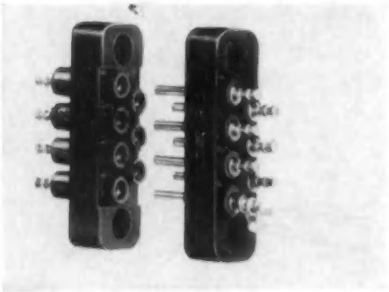
For more information—
Circle 44, inside back cover

Molded Phenolic Jack Strips

Each jack strip provides mounting spaces for 52 single (26 double) jacks. Horizontal and vertical hole spacings are arranged so that either single or double plugs can be used.

Two types of mounting brackets are available: flush mounting or standoff. Jack strips are also available without brackets. Lenkurt Sales Co., County Road, San Carlos, Calif.

For more information—
Circle 45, inside back cover



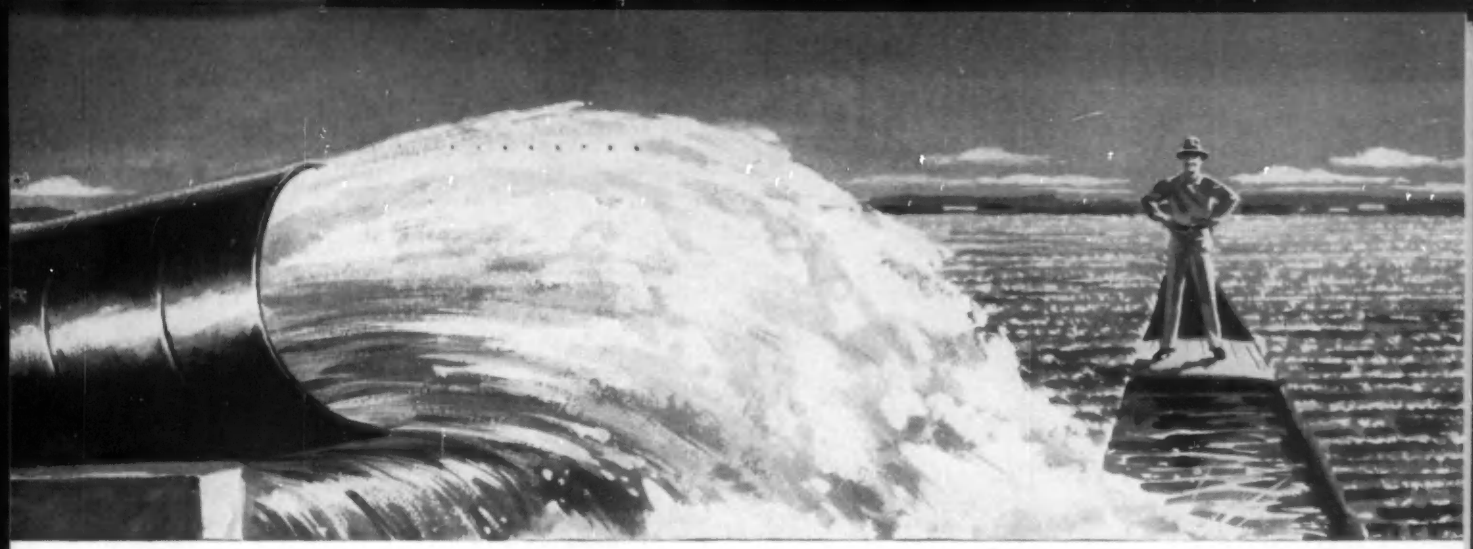
Contact Terminals

Two styles of contact terminals that are said to facilitate assembly wiring or increase the operating current of electrical connectors are now available in the miniature, quick-disconnect and small power connector class.

The turret terminals permit wrap-around wiring of two or more wires per contact, or, if preferred, allow the use of larger AWG wire than that formerly permitted by conventional solder cup terminals.

Internally-tapered terminals are designed for use with No. 53 AMP taper pins to speed individual wire attach-

CONTINUED ON PAGE 228



576 million gallons of water in 9600 hours

. . . that's average for a Chrysler Industrial V-8-powered irrigation pump in West Texas

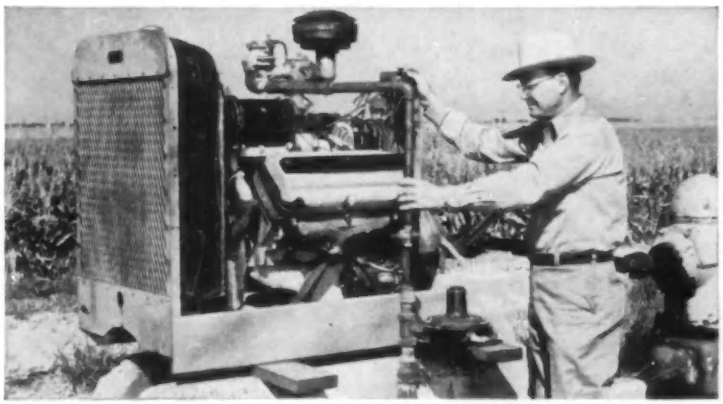


Photo courtesy Louthan-Dowell Motors, Lubbock, Texas

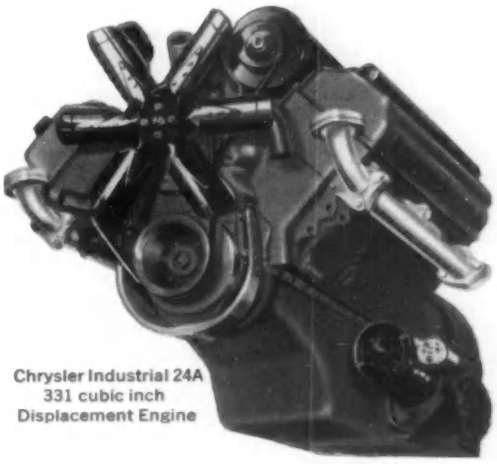
Lloyd Huffaker, Lubbock, Texas, stands beside his Chrysler Ind. 24A-powered irrigation pump. In 2½ years, Mr. Huffaker has irrigated three crops of cotton, maize and alfalfa, his pump and Chrysler Industrial Engine operating approximately 133 twenty-four hour days during each season. Pump has delivered an average of 1000 gallons per minute, for a grand total of 576,000,000 gallons of water. Total maintenance repair in 2½ years: One set of spark plugs and three sets of points installed at total cost of $10.00. If the total revolutions this engine has turned were reduced to miles, they would equal approximately 336,000 miles—or more than thirteen times around the world.

Ask any grower in West Texas what the local performance record for an irrigation pump is and, chances are, he won't know . . . records are broken every day in Texas. He just assumes his pump will bring water up approximately 320 feet in sufficient quantity to irrigate his entire crop every day of his 120 to 200 day growing season.

But ask any West Texas grower *what engines* power his irrigation pumps, and if he's like better than 85% of West Texas growers, he'll tell you — Chrysler Industrial. And if you ask him why, you will get an answer based upon better than fifteen years experience — his own and his neighbors'.

For instance, a West Texas grower might tell you that, among lightweight high-speed engines operating on either butane or natural gas, Chrysler is the only engine equipped with all the truly *industrial* engine features. As examples he could mention features like sodium-cooled exhaust valves with extra-hard stellite valve heads and valve seats, heavy duty induction hardened crankshafts and large tri-metal bearings. Finally he would probably point out that a single Chrysler Industrial Engine has been driving his centrifugal pump nearly ten years without a major overhaul while during the same period competitive power plants may likely have required two or three overhauls.

If it's real industrial power *you* need . . . for irrigation or any other equipment, you can't buy an industrial engine to equal Chrysler, 230 to 413 cubic inches displacement. For details, see a Chrysler Industrial Engine Dealer, or write: ***Dept. 65, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***



Chrysler Industrial 24A
331 cubic inch
Displacement Engine

CHRYSLER
Industrial Engines

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

HORSEPOWER WITH A PEDIGREE

ment and permit selective engagement or disengagement of wires. Winchester Electronics, Inc., Dept. K, Norwalk, Conn.

For more information—
Circle 46, inside back cover

Crimp Connector Has Wrap-Around Insulator

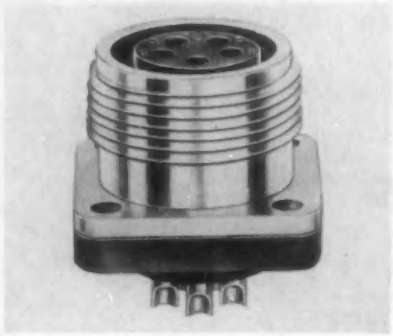
This connector for wires in branch circuits and fixtures has two parts, a cadmium-plated steel sleeve and a vinyl cap. The unit is applied by crimping the sleeve after it is slipped over wires being connected. Electrician's pliers with a special crimping die are used. The insulator is pushed down over the crimped sleeve and wires and then its tabbed cap is drawn down between the wires and up over the end of the joint.

The connector is made in two sizes and is said to be approved for 600-v pressure cable, where No. 14 through No. 10 are in use. Ideal Industries, Inc., Sycamore, Ill.

For more information—
Circle 47, inside back cover

Sealed Instrument Receptacle

This receptacle has only two pieces, an aluminum shell and a neoprene or silicone rubber insert with permanently bonded pin or socket contacts.



All materials are non-magnetic. Rubber O-rings molded as a part of the flange, both front and rear, form automatic seals when the insert is mounted in the shell, making additional gasketing unnecessary.

Pin or socket contacts are available. Whitney Blake Co., New Haven 14, Conn.

For more information—
Circle 48, inside back cover

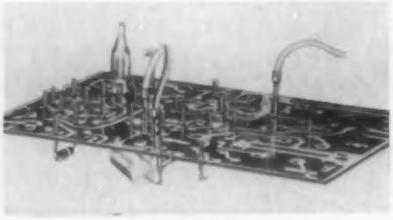
Provides Firm Connection In Both Old and New Outlets

A plug contact for electric cord set attachment has prongs of a bowed design that presses outward against receptacle contacts. It also incorporates a precision-formed anchor loop at the end which holds the contact securely in the receptable. This combination is said to provide greater holding power than ordinary straight contact blades, eliminates accidental disconnect, and prevents the partial dislodgement that causes overheating in worn outlets. General Electric Co., Bridgeport, Conn.

For more information—
Circle 49, inside back cover

Miniature Terminals and Contacts

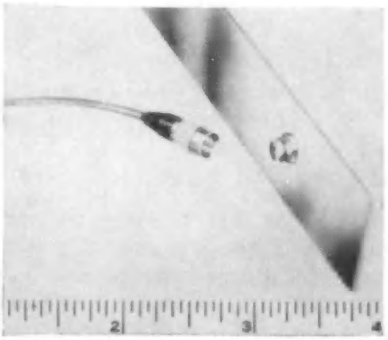
Miniature tubular pins and female contacts, said to be the first self-retaining terminals developed for this purpose, are readily adapted to numerous wiring problems. Two beads on the lower part of the pin terminal depress and snap out again when pushed



through an accommodating panel hole. The pin snaps into the panel with a positive locking action, eliminating roll-over operations and possible fracturing of panel or chipping of plating. This locking action retains the pin until additional components are added and until it is permanently soldered.

Resistor, capacitor, condenser and neon pigtails can be fed into the terminal at either the top or bottom of the panel and held in place by tapered portion of the terminal until solder-dipped. External leads from other components can be wrapped around the pin terminals and spotsoldered. Both the pin and contact can be supplied in chain form for automatic feeding and crimping operations. An automatic inserting machine is available for feeding. Malco Tool and Mfg. Co., Dept. PEN, 4025 W. Lake St., Chicago 24, Ill.

For more information—
Circle 50, inside back cover



Quick-Connect Plugs For Miniature Coaxial Circuits

These plugs are available in 50, 70 and 93-ohm types. Also included in the series are jacks, feed-thrus, bulkhead receptacles, adapters for BNC, ell, tee, cross adapters and specials.

All connectors are 100 per cent

CONTINUED ON PAGE 230

Which is the CleCap?

. . . the one you can get pronto!

A much-used fastener style these days—socket screws. But it's surprising how scarce they can be in *the size you want* RIGHT NOW! CleCap have made it a point to make and stock *all* the popular sizes in this popular style. What's more, you can get *extra large* sizes when you need them.

We can't resist a rave about the product—CleCap's double extruded Socket Screws . . . Real *sockets* you'll admire—they're true hex, sharp cornered to give the key good "purchase", and *clean,* clear to the bottom.

"Sockets" are just one of the fastener styles CleCap makes. On any of the items cataloged below, let CleCap show you how they can make your idea of delivery a reality. If you haven't tasted CleCap service you've missed a thrill.

The Cleveland Cap Screw Company

2936 East 79th Street • Cleveland 4, Ohio • VUlcan 3-3700 TWX CV42

Warehouses: Chicago • Philadelphia • New York • Providence • Los Angeles

CLEVELAND *Top Quality* FASTENERS

Ferrous and Non-Ferrous: Bright, High Carbon and Alloy Steel Heat Treated, Brass, Silicon Bronze, Stainless Steel

Hex Head Cap Screws: ¼" to 2½" dia.
Socket Head Cap and Set Screws—Plain and Knurled: ¼" to 1½" dia. Also Flat and Button Head Styles.
Flat Head Cap Screws: ¼" to 1" dia.
Fillister Head: ¼" to 1¼" dia.
Set Screws—Square Head: ¼" to 1½" dia.
Milled Studs: ¼" to 1¼" dia.
Place Bolts: ¼" to 1¼" dia.
Structural Bolts to ASTM Specification A325
Tractor Bolts
Special Hot and Cold Headed Parts

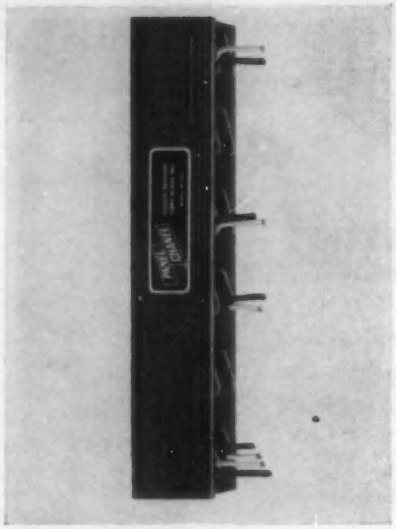
Facilities to make larger diameters than listed.

Ask Your Jobber for CleCap!

Originators of the Kaufman DOUBLE EXTRUSION Process

Teflon dielectric. The finish is silver plate with pins gold-plated. The standard type 50-ohm unit has a length of 0.73 in. with nut OD of 0.225 in. The weight is 0.08 oz. Microdot, 1826 Fremont Ave., S. Pasadena, Calif.

For more information—
Circle 51, inside back cover



Plastic Wiring Duct

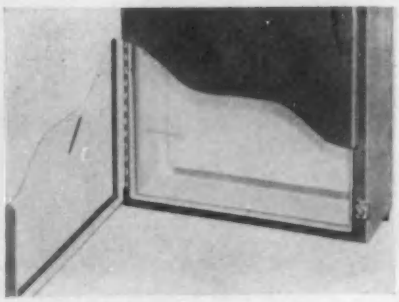
This duct has a laminated phenolic resin, one-piece, U-shaped channel and an extruded high impact polystyrene cover. The cover is removed for maintenance or wiring changes by compressing its sides. Wire lead-out slots are angled. The duct is available in sizes ranging from 1 x 1 in. to 3 x 3 in. Stahlin Bros. Fibre Works, Inc., Belding, Mich.

For more information—
Circle 52, inside back cover

Sheet Metal Enclosures

Fifteen standard sizes of NEMA 12 sheet metal panel enclosures (16 x 12 x 6 in. to 60 x 36 x 8 in. are constructed to be completely liquid tight, according to the manufacturer. All seams are welded. There are no holes. The cover is gasketed with neoprene sponge.

There are external mounting feet. The cover is hinged on one side with a continuous type hinge. It is fastened



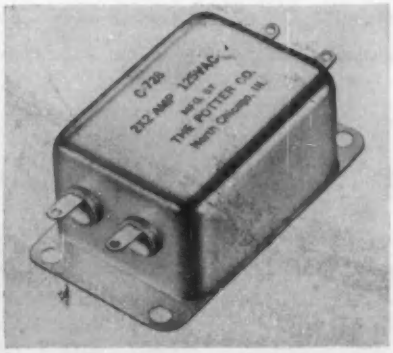
to the box by means of external clamps. There is a print holder on the inside of the cover. There is a removable mounting panel for mounting electrical equipment. The interior is finished with a baked white enamel and the outside with a prime coat. Hoffman Engineering Corp., 1148 Tyler St., Anoka, Minn.

For more information—
Circle 53, inside back cover

Miniaturized High Insertion Loss Filters

A series of small high insertion loss filters for aviation and mobile electrical and electronic equipment are available in ratings from 0.1 to 20 amp for both 125 v, dc, and 125 v, ac, 400 cycle service. Sprague Electric Co., 195 Marshall St., N. Adams, Mass.

For more information—
Circle 54, inside back cover



Line Filter For 115v, Ac

Intended as a component in high frequency units, this filter enables units of this type to meet FCC radiation requirements of 15 microvolts per meter at 100 ft.

UL requirements of 5 milliampere current to ground are also met. It is available for any current rating and in a wide variety of shapes and mounting arrangements. Potter Co., 1950 Sheridan Road, N. Chicago, Ill.

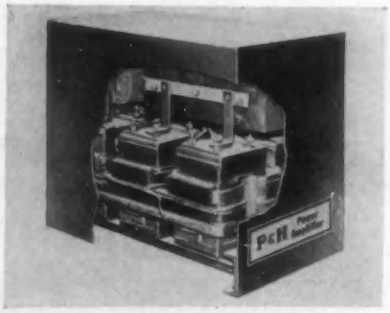
For more information—
Circle 55, inside back cover

Hook-Up Wire With Two or Three Stripes

Teflon-insulated hook-up and lead wire previously made only in solid colors is now being manufactured with two or three color-coded stripes. Colors remain bright up to 260 C heat, light or solvents and conforms to MIL-STD 104.

Extruded high temperature wire is produced in sizes from No. 10 to No. 26 AWG, in two ratings. Type TX is rated for 600 v rms, Type HX for 1000 V rms. Conductors are silver-plated, stranded or solid copper. Hi-temp Wires, Inc., 26 Windsor Ave., Mineola, N. Y.

For more information—
Circle 56, inside back cover



Power Amplifier Gives Variable D-c Power

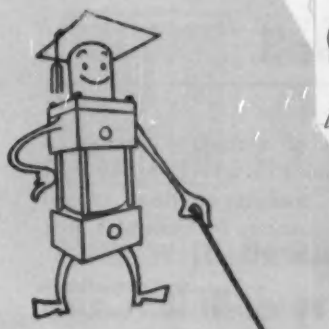
A nonrotating source of d-c power provides variable speed under stepless control. In operation, performance can be likened to adjustable voltage systems, except that this amplifier does not have any rotating parts. Input power can be any phase and voltage combination.

The new amplifier is designed around durable transformers, saturable reactors and rectifiers. It is a self-con-

CONTINUED ON PAGE 232

Miller

FLUID PRESSURE BOOSTERS

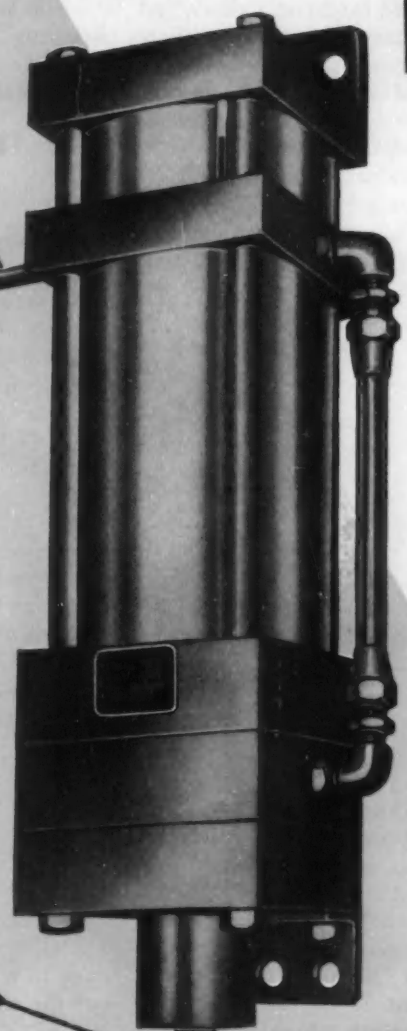


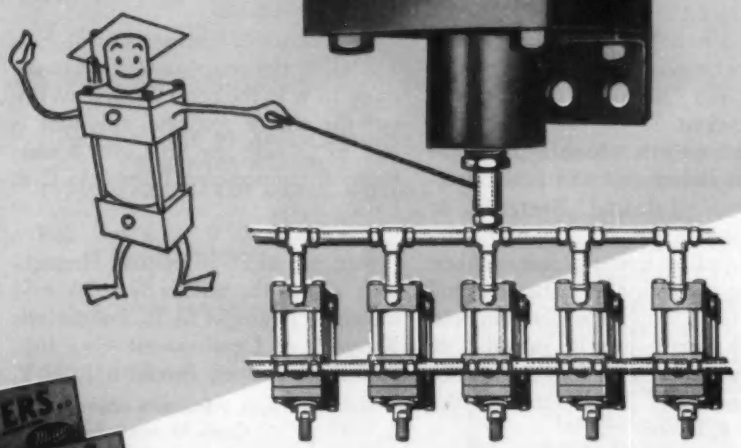
BOOST 80 PSI AIR

Input Range: 40 to 3000 psi Air or Fluid

TO 2000 PSI HYDRAULIC PRESSURE

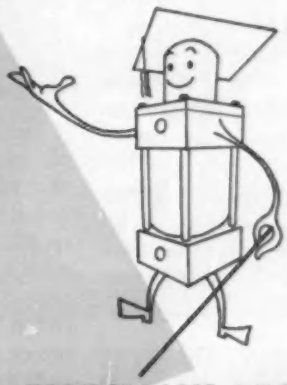
Output Range: 200 to 10,000 psi Fluid





- Save space, weight and investment cost by replacing pump installations in many applications
- Less costly to install, operate and maintain
- **Hold pressure indefinitely** without the motion and heat generation of ordinary pump circuits
- Provide — at point of cylinder thrust — more efficient power with less weight in less space than direct driven air cylinders
- Save up to 95% of air consumed by direct driven air cylinders
- Operate at speeds of 30 to 450 strokes per minute

NOTE: In addition to its most complete line of "Custom-Built" Boosters available on normal delivery, Miller offers 5" bore, 25 to 1 ratio, boosters for immediate delivery in either 6" or 12" stroke. Write for data and prices.



ESPECIALLY RECOMMENDED FOR

- **WELDING**
- **PUNCHING**
- **SHEARING**
- **CLAMPING**
- **RIVETING**
- **CRIMPING**
- **PRESSING**

and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST

Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

MILLER FLUID POWER CO.

(Formerly MILLER MOTOR COMPANY)

2002-04 N. HAWTHORNE AVE. • MELROSE PARK, ILL

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

tained unit. Control can be achieved electronically, by a simple rheostat or any other arrangement. It is built in a range of standard sizes from 1 through 30 hp. Harnishchfeger Corp., 4621 W. National Ave., Milwaukee, Wis.

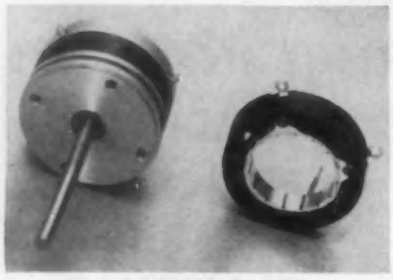
For more information—
Circle 57, inside back cover

Miniature Electronic Amplifier

This is a transistor preamplifier which may be used to ampilfy extremely weak electrical signals to the point where they have sufficient strength to be examined and measured by laboratory test equipment. It is reported to be capable of amplifying by one thousand times an electrical signal as small as a millionth of a volt and whose power is only a billionth of a watt. The unit, which is approximately 5 in. long is about 1 in. sq.

The unit is operated by a battery of four mercury cells, about the size of four shoe buttons, which last 1000 hr. The unit has a referred-to input noise of only 1 microvolt. Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

For more information—
Circle 58, inside back cover

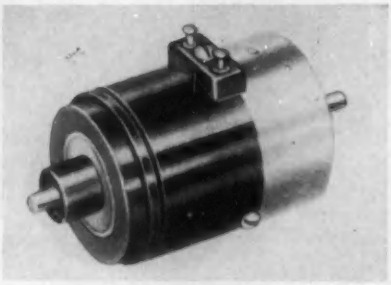


Commutator and Impulse Generator

This miniature potentiometer is intended for use as a high-speed switching device for counting, digital indication of shaft rotation, pulse shaping, pulse gating, sequence circuit control.

The commutator generator consists of a series of conducting segments, bonded to a high temperature plastic base, insulated from one another, and inter-connected to form a wide variety of coded commutation or pulse sequences. The element is approximately 1 in. dia and weighs 2/10 oz. Precious metal contacts are employed throughout. Operational speeds up to 1000 rpm are permissible, with a life in excess of 1 million revolutions. Computer Instruments Corp., 1964 Utica Ave., Brooklyn 34, N. Y.

For more information—
Circle 59, inside back cover



Clutch or Clutch Brake

These units operate on the principle of an electro-magnetic actuation of a friction plate to provide virtually instantaneous starts and stops. Response speed is measured in milliseconds and is dependent upon application. Energizing the coil engages the clutch and provides instantaneous power pickup.

When coil is de-energized, the clutch is disengaged and braking action occurs, if desired. Energizing or de-energizing can be remotely controlled by vacuum tubes, limit switches, relays or other devices. Standard coil voltage is 28 v, dc; however, coil voltage and current can be provided to meet customer requirements. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

For more information—
Circle 60, inside back cover

Potentiometers for Industrial Applications

These potentiometers are available in single or ganged assemblies in three sizes, 3, 1⅜ and 1¼ in. dia. Mounting, by means of threaded bushing, is standard on P1¼ and P1⅜. The P3 mounting consists of three tapped holes. Technology Instrument Corp., Acton, Mass.

For more information—
Circle 61, inside back cover

Voltage Amplifier

This unit is a direct coupled two-stage amplifier having an output through a capacity network. The time constant of the output network is suitable for operation at frequencies down to 1 cps. While extremely small (2⅝ x 4⅝ x 8 in.), this amplifier is a complete unit with built-in power supply ready for immediate operation.

This amplifier has a peak-to-peak voltage output up to 10 v with less than 2½ per cent distortion, 30 v with 6 per cent and over 50 v at saturation. Requires 16 w, 115 v, 60-cycle power supply. Weight is 4 lb. Electro Products Laboratories, 4503 N. Ravenswood Ave., Chicago 40, Ill.

For more information—
Circle 62, inside back cover

Amplifier for 60 Cps Servo Motors

This saturable transformer will drive 115 v, 60 cps servo motors, requiring up to 16 w to the control phase. Without the use of rectifiers, this unit is said to provide low drift over a wide range of temperatures from −55 C to 85C.

Bandwidth is 0 to 3 cps, and a power gain of 20 is realized. Hermetically sealed, the unit is 3⅞ x 3 7/16 x 5¼ in. high. It weighs 6½ lb. Polytechnic Research & Development Co., Inc., 202 Tillary Street, Brooklyn 1, N.Y.

For more information—
Circle 63, inside back cover

Counts Angular Change

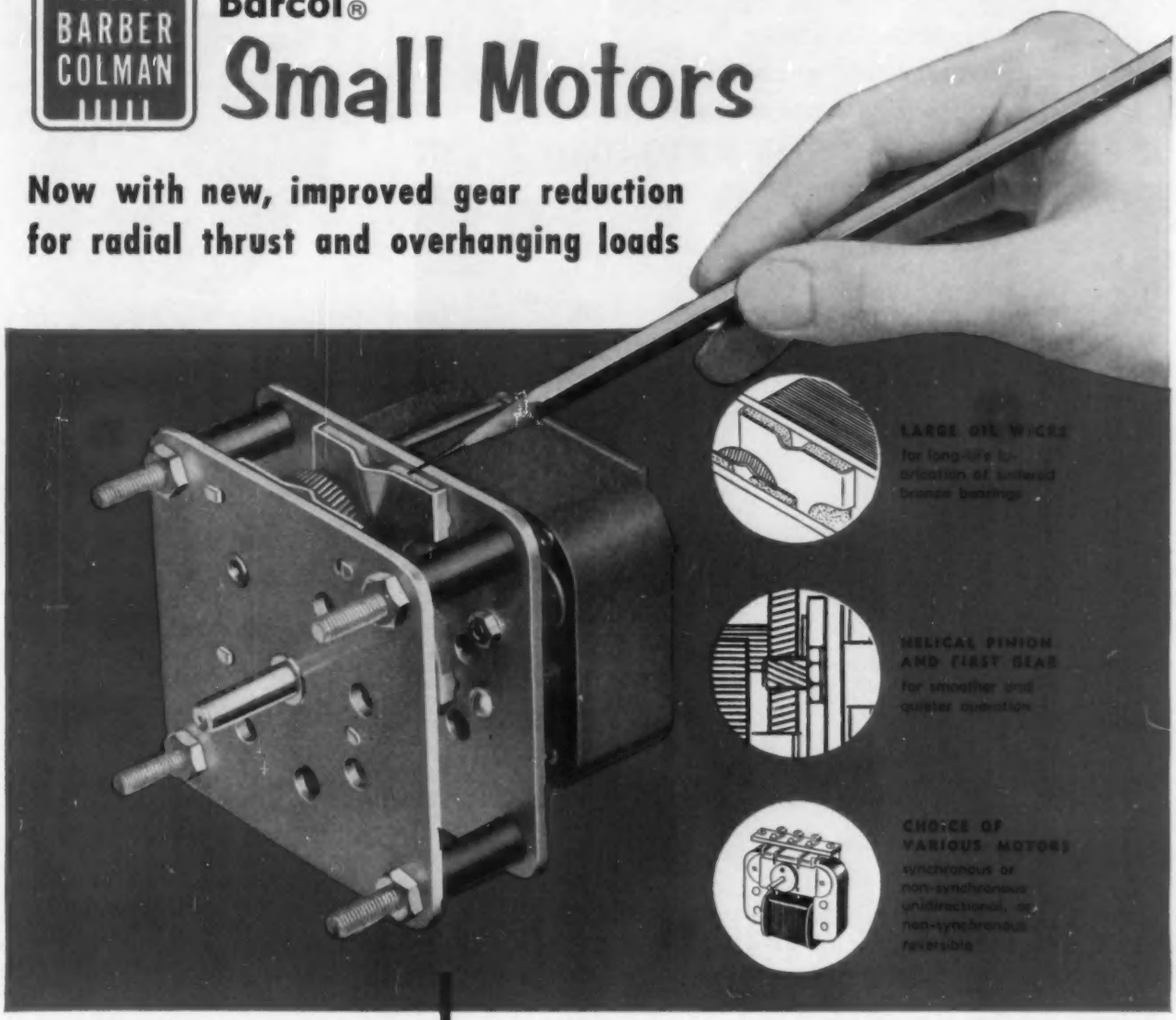
This unit indicates angular changes from 0 to 359 deg and back to 0, in 1-deg divisions. One revolution of the input shaft is equal to one revolution of the unit drum. The counter is equally useful in clockwise, counter-

CONTINUED ON PAGE 234

BARBER COLMAN

Barcol® Small Motors

Now with new, improved gear reduction for radial thrust and overhanging loads


LARGE OIL WICKS
for long-life lubrication of sintered bronze bearings
HELICAL PINION AND FIRST GEAR
for smoother and quieter operation
CHOICE OF VARIOUS MOTORS
synchronous or non-synchronous unidirectional, or non-synchronous reversible

WIDE RANGE OF APPLICATIONS FOR NEW BARCOL TYPE DYAZ GEARED SMALL MOTORS

Vending Machines

Chart and Pen Drives

Timers

Tape Winders

Office Machines

Telemetering Equipment

Barbecue Spits

TV Tuners

Slide Changers

X-ray Machines

And many more

Here's a new line of Barcol geared motors designed for applications involving overhanging or radial thrust loads.

The new Barcol DYAZ open-type geared motor offers extra ruggedness, quietness, and dependability. Double-supported gear shafts run in sintered bronze bearings which are assured long-life lubrication through extra large oil wicks. Uses *heavy duty* gears and output shaft. Helical pinion and first gear step provide quieter, smoother performance. Frame plates are of anodized aluminum with four mounting bolts extending through the front plate.

This advanced type Barcol geared motor is available in gear ratios from 4:1 to 30,000:1. Starting torques up to 75 lb-in. Your choice of synchronous or non-synchronous unidirectional motors, or non-synchronous reversible motors.

Get the complete story now—write for new illustrated Bulletin F-6841 on Barcol DYAZ Geared Motors.

Barber-Colman Company

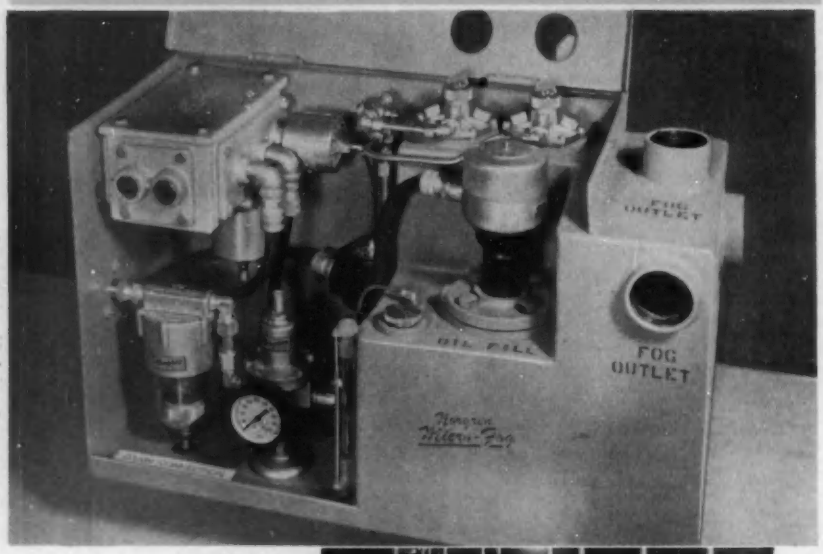
Dept. Q, 1212 Rock Street, Rockford, Illinois

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls • Air Distribution Products • Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

FOR DESIGNERS OF MACHINE TOOLS

an easy, effective way to
cut manufacturing costs
add important operating features

NORGREN MICRO-FOG 33AB LUBRO-CONTROL UNIT



Model 33AB-4 lubricates 350 bearings and 170 spur gears on large Cross Transfer-Matic using only 1.6 fl. oz. of oil per hour and 10 cfm. of air.

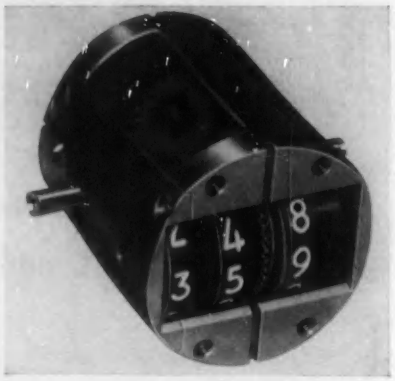
1. Produces a high concentration of oil fog —provides maximum transmission with minimum air consumption.
2. Capacity to lubricate up to 1000 bearing inches.
3. Produces a fine fog that is uniformly distributed to multiple outlets, assures thorough, dependable lubrication at every bearing surface.
4. Reduces cost of installation and maintenance of bearing and gear box seals.
5. Eliminates the need for many smaller lubricators and complex piping systems.
6. Pressure switches and liquid level controls automatically actuate alarm system or stop machine a) when oil supply reaches a pre-selected low level, b) when air pressure fails, c) when excessive pressure develops in oil supply tank.
7. Solenoid valve starts and stops the Micro-Fog Lubrication system as the machine is turned on and off.
8. Maximum flexibility in control of Micro-Fog: two high capacity lubricator heads may be used simultaneously or individually, depending on fog requirements; oil feed regulated by applied pressure over a wide pressure range.
9. Three 2" Micro-Fog outlets may be used separately or in combination to facilitate connecting and routing of distribution piping. Air inlet is ½" pipe size.
10. Rate of oil feed visible through sight feed dome on each lubricator head.
11. Oil gauge on tank visually indicates oil level.
12. Automatic-Drain Filter removes moisture and solids from air line, drains collected moisture automatically, prevents contamination of oil supply.
13. 1" conduit connection serves centrally located water-tight junction box.

For engineering information on the application of Micro-Fog Lubrication, write for Norgren Blueprint MF10. Or ask for our engineering service to help you on your specific applications.

C. A. Norgren® CO.
3428 So. Elati, Englewood, Colo.

PIONEER & LEADER IN OIL FOG LUBRICATION FOR 27 YEARS

- Oil Fog Lubricators
- Pressure Regulators
- Air Filters • Valves
- Hose Assemblies



clockwise or reversible applications, according to the maker.

Input speed is rated at 500 rpm. Housing material is black anodized aluminum for light weight (within 2.5 oz.) Bowmar Instrument Corp., 2415 Pennsylvania St., Fort Wayne, Ind.

For more information—
Circle 64, inside back cover

Wire-Wound Resistor 7/16 x 3/16 In. Dia.

A maximum resistance of 180,000 ohm can be wound on this resistor. It will dissipate ¼ w at 125 C without derating. Tolerances as close as ±0.02 per cent can be obtained. Daven Co., 191 Central Ave., Newark 4, N. J.

For more information—
Circle 65, inside back cover

Flat Wire-Wound Resistors

This non-inductively wound resistor will remain stable under all climatic conditions within an ambient temperature range of −65 C to 125 C, according to its manufacturer. It is available in ⅓, ½, ¾, 1 w sizes. Standard performance tolerances down to 1/20 of 1 per cent are available. RHO Engineering Co., 420 Sepulveda Blvd., Culver City, Calif.

For more information—
Circle 66, inside back cover

High Speed Sampling Switch

A sampling switch with three synchronized poles has been developed. It is also available with from one to

here's typical example of how manufacturers reduce maintenance costs and protect equipment against air line contaminants

with

An automotive electrical equipment manufacturer uses a Norgren Automatic-Drain Filter, Model 11,200-2(25), to protect bearings and component parts of a 9/16" automatic screw machine against air line contaminants.

NORGREN AUTOMATIC-DRAIN FILTER

Norgren Automatic-Drain Filter (¼", ⅜", ½" sizes) for air tools, air cylinders and Micro-Fog Lubrication systems offer these advantages:

1. Removes abrasive grit and pipe scale.
2. Solids are filtered out before air enters drain chamber, reducing possibility of plugging drain mechanism.
3. Removes corrosive moisture.
4. Drains collected moisture automatically.
5. Discharges only under full load to reduce wear and loss of air.
6. Drain operates independently of air pressure fluctuation and air flow.
7. Prevents contamination of oil supply.
8. Low pressure drop.
9. Reduces air line maintenance operations.
10. Cuts air equipment repair costs.

Flow: 0 to 35 cfm.

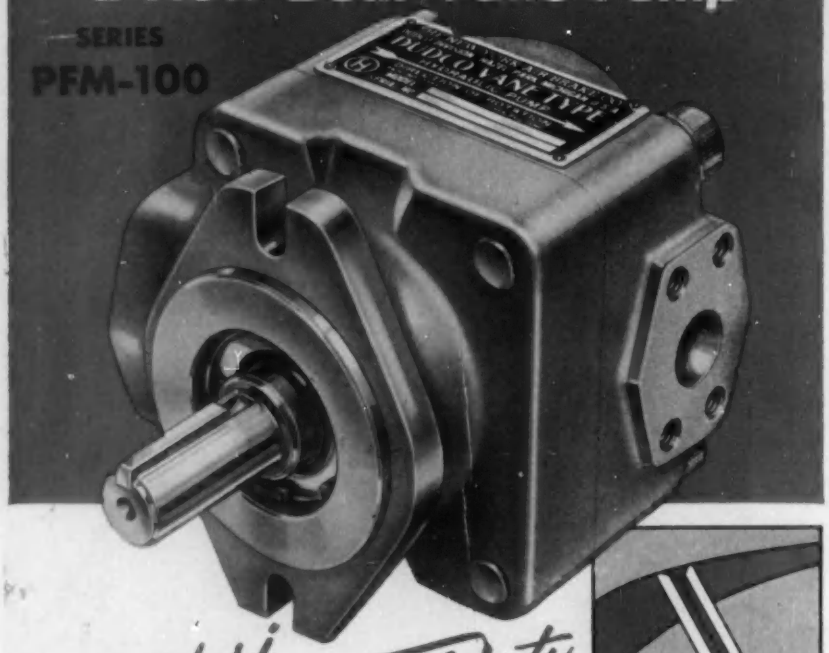
Pressure: 30 to 150 psi.

WRITE FOR COMPLETE INFORMATION

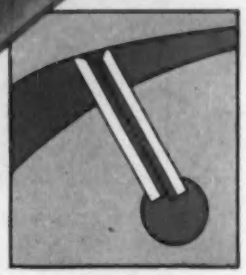
C. A. Norgren CO.
3426 So. Elati, Englewood, Colo.

Oil Fog Lubricators • Pressure Regulators
Air Filters • Valves • Hose Assemblies

DUDCO PRESENTS • • •
for MOBILE EQUIPMENT
a New Dual-Vane Pump
SERIES
PFM-100



2000 psi Continuous Duty
3 to 11 gpm at 1200 rpm 0 psi



TWO VANES ARE BETTER THAN ONE

The hydraulically counter-balanced DUAL-VANES in DUDCO Hydraulic Pumps eliminate wear producing loads normally caused by unbalanced hydraulic forces and vane acceleration. DUAL-VANES also maintain MULTIPLE SEALING BARRIERS to slippage and power loss. DUAL-VANES are a patented and exclusive DUDCO feature.

This Pump was engineered to meet the special conditions characteristic of service on mobile equipment.

Here is a pump designed for high speed direct engine drive that can be operated *continuously* at *2000* psi and *2000* rpm to meet the continuing demand for more work from your equipment.

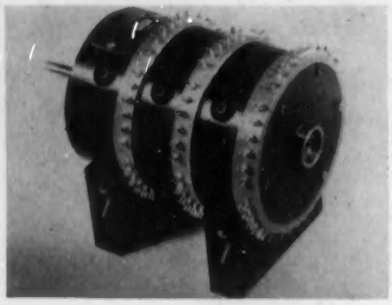
The exclusive DUDCO Dual-Vane design provides and assures *complete hydraulic balance* of all internal parts. Bearing loads and cam ring wear are reduced so DUDCO PFM-100 Pumps last longer.

Designing these Pumps into your machines is made easier because all standard S.A.E. or industrial mountings and piping provisions are available, as well as complete flexibility of port positions.

PFM-100 Series Pumps are priced for the competitive mobile equipment market . . . NO price penalty for high pressure equipment.

Write — for complete information on the new DUDCO PFM-100 Series DUAL-VANE Hydraulic Pump.

DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1112 EAST 222nd STREET • CLEVELAND 17 • OHIO
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.



six poles, each pole being capable of sampling up to 30 non-shorting channels.

The contact plate is of semi-molded construction and individual phasing arrangement is provided. A range of variations of contacts and terminals are available. Dimensions are: length including shaft, 3 in., diameter minus base, 2⅝ in. General Devices, Inc., Dept. SP, P.O. Box 253, Princeton, N. J.

For more information—
Circle 67, inside back cover

Tantalum Capacitors

These capacitors are rated from −55 C to 125 C. Units rated to 175 C can be supplied on specific order. Standard case size is ½ x ⅞ in. to 120 mfd; only slightly larger to 240 mfd. Series combinations can be supplied at higher capacities and voltage ratings. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

For more information—
Circle 68, inside back cover

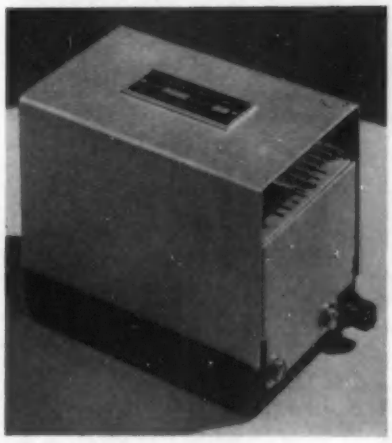
Rectilinear Motion Potentiometers

Potentiometers specifically designed for applications where a system voltage exceeds that which is desired across

the potentiometer are internally regulated so that each position of the wiper corresponds to a fixed fraction of system voltage which remains stable despite wide temperature variation. These units contain conductive plastic-fixed resistors, molded together with the conductive plastic potentiometer resistive track, terminals and center tap to a mineral-filled plastic insulator support.

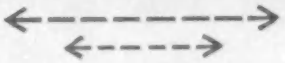
Output stability is maintained since the conductive plastic potentiometer element and fixed resistors are matched in temperature coefficient of resistance. They are located on a single supporting structure which acts as a thermal sink to minimize power heating differences, and are in a single temperature zone. The Type 2134 has a stroke of 1¾ in. and the Type 2135 a stroke of 3⅛ in. Both potentiometers are also now available as standard units without internal trimmers. Markite Corp., 155 Waverly Pl., New York 14, N. Y.

For more information—
Circle 69, inside back cover

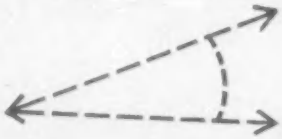


Pressure-Operated Potentiometer

This potentiometer is for applications where the output voltage is to be a non-linear function of pressure. The instrument consists of a ruggedized, pressure-operated potentiometer having taps and provision for resistance loading across the winding. The instrument mechanism operates in a hermetically-sealed evacuated container inside of the instrument case. A resistor board designed to accommodate loading resistors is external to the evacuated case and may be reached by removing the outside cover. The in-



Even simple functions may entail special configurations to give maximum results...



Or, when the function involves motion in more than one direction, custom design develops mountings to suit the application...

Or cylinder movement in any direction, and many other variables are yours with HYDRECO Custom Design.

For the engineer whose target is equipment that will outperform any comparable unit—the special facilities offered by HYDRECO can materially assist in attaining the objective. Not with so-called "standard" cylinders but rather with cylinders custom engineered and built to do the specific job.

Requirements of space, mounting, or hydraulic connections that could never be met by "standard" cylinders, can be fulfilled easily through custom designing.

And too, HYDRECO's variety of experience in designing and building special hydraulic components in volume production can keep the product costs within the budget.

That which is true of HYDRECO Cylinders is equally true of HYDRECO Pumps, Motors and Valves. To improve the performance of existing equipment or to add functions *and* complete dependability to projected designs—look to HYDRECO Oil Power!

WRITE— for full information today on HYDRECO Pumps, Motors, Valves and Custom Built Cylinders.

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1112 EAST 222nd STREET • CLEVELAND 17 • OHIO
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

FOR ECONOMY IN MANY SEVERE SERVICES . . . it's hard to beat Shenango *centrifugally* cast parts of Meehanite Metal. These assembled rolls with steel journals are typical, long-lived examples. The combination of Shenango centrifugal casting and Meehanite Metal means pressure-dense grain for a smoother finish, less waste, greater strength and superior wear resistance. Porosity, sand inclusions, blow holes and other troublesome defects are a problem of the past. For informative bulletins on Shenango centrifugally cast parts—rough, semi- or finish-machined, ferrous *or* non-ferrous — write to: Shenango-Penn Mold Company, Centrifugal Castings Division, Dover, Ohio (Executive Offices: Pittsburgh, Pa.).

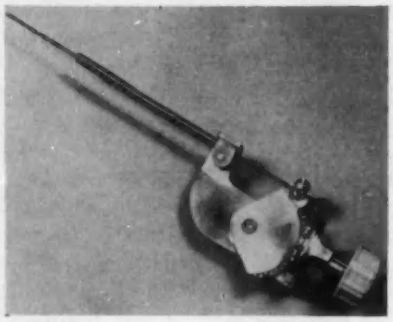
SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES • MONEL METAL
ALUMINUM AND MANGANESE BRONZES • NI-RESIST • MEEHANITE METAL

strument can be made linear with respect to altitude, air speed, and many other aerodynamic functions.

The potentiometer wiper moves linearly with pressure over the range 3.42 to 30.36 in. of mercury (−400 to 50,000 ft). Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.

For more information—
Circle 70, inside back cover



Remote Operation of Valves, Vents, Dampers

According to the manufacturer, this sector gear-and-pinion device will produce 1½ in. of linear push-pull motion by turning its knob 270 deg. The external portion of the control occupies 1¾ x ¾ in. of panel area with 2½ in. of clearance behind the panel. It requires one nut for mounting. Construction is of plated steel and operation of the unit is not affected by dust or grit. Arens Controls, Inc., 2017 Greenleaf St., Evanston, Ill.

For more information—
Circle 71, inside back cover

Absolute Pressure Control

This control is based on a completely evacuated bellows and provides positive switching action in response to source pressure variations independent of atmospheric pressures and temperatures. This control has been used to control the action of pressurizing pumps when absolute pressures must be maintained on airborne, mobile or other equipment.

The bellows is spring-loaded to insure quick, accurate response to pressure variation. The expansion or contraction of the bellows, due to changes in pressure, actuates a snap-acting switch. The control can be factory set anywhere between the range limits of 0 to 35 psi with a differential choice

Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

WAGNER offers something NEW in small motors

More compact capacitor-start and split-phase motors—¼ hp and below—*that help the design engineer in a tight spot!*

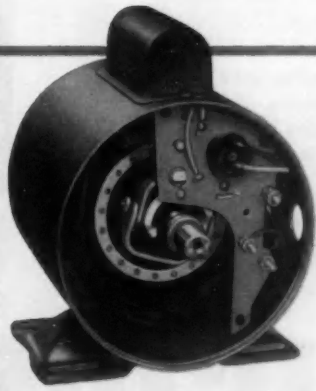
For design engineers who've been looking for more efficient fractional horsepower motors with less bulk... here's good news!

Now, you can get smaller, more compact Wagner capacitor-start and split-phase fractional horsepower motors with many new added features such as *a new endplate design, a new lubrication system that permits all-angle mounting and a new terminal board and switch location.*

Yet these re-designed motors retain all of the proven features that have made Wagner motors famous for quality for more than 60 years. Bulletin MU-200 gives complete information—write today for your copy.

When you specify Wagner Motors—you get the advantage of a liberal warranty... of nationwide service facilities, with on-the-spot service, replacement motors and parts available from 25 Wagner-owned Service Branches and more than 850 Authorized Service Stations. You can choose from a wide variety of types and sizes—singlephase or polyphase—from 1/25 to 400 horsepower.

Inside view of sleeve bearing endplate with seal removed to show felt packing used for lubrication. In addition to the continuous strip, a spring-loaded piece of felt makes constant-pressure contact with the shaft through an opening in the top of the bearing.



View of the type RK motor with endplate removed showing terminal board on which thermal protector and quick-break switch are mounted. Note thickness of steel frame which has been machined for accurate endplate fit. Rigid base is welded directly to the frame.

Wagner Electric Corporation
EST. 1891

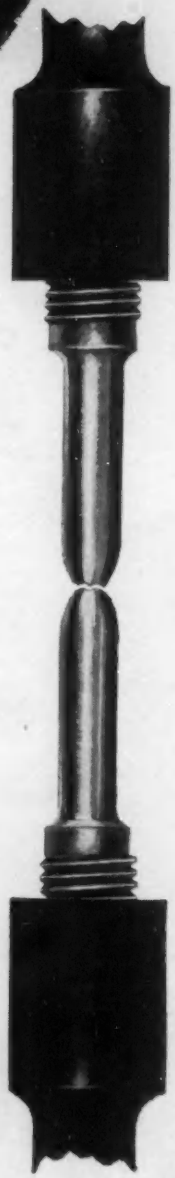
Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

M55-12

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

INSIDE STORY
AUSTENAL
SILENT
TREATMENT



This is the inside of a creep rupture machine at Austenal Laboratories. A bar of ultra-strong alloy is subjected to high stress for many hours at jet engine temperatures until it finally ruptures.

The drawing symbolizes determination of rupture strength of an alloy to be used in Austenal's Microcast process for the investment casting of high temperature components for jet engines. This is one of many laboratory tests used to ensure the quality and dependability of the alloys used.

The alloy was made in Austenal's own alloy plant. Skilled metallurgists and chemists produce alloys to pre-determined specifications and check and re-check each individual melt to ensure high quality standards.

Quality control is basic in Austenal's Microcast process. It is just one of the reasons why more jet engines use Austenal components than any other—and why American industry depends upon Austenal.

Let Austenal help solve *your* precision casting problems. Austenal Microcast can simplify and improve your entire production picture.

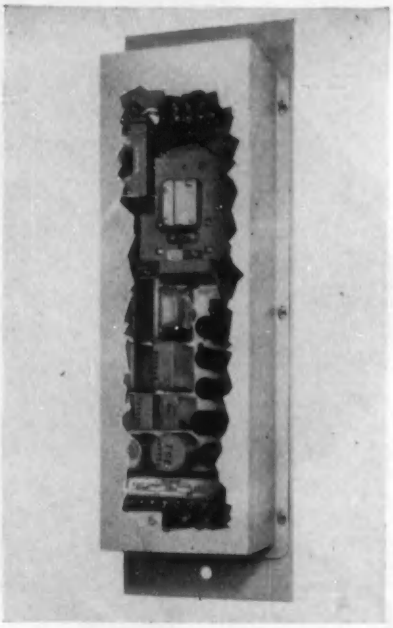
See Austenal's original informative 16mm color movie, "A Story of Industrial Progress". Available without charge.

austenal®
LABORATORIES, INC.
microcast division
224 EAST 39th STREET • NEW YORK 16, N. Y.
7001 SO. CHICAGO AVE. • CHICAGO 37, ILL.

between the limits of 1.5 and 5.0 psi. The type J20 control has an adjustable range of 5.0 psi and a repeat accuracy of 0.1 psi between −65 F to 160 F, altitude to 60,000 ft, and 100 per cent relative humidity.

The single-pole, single-throw snap-acting switches used on this control are rated at 4 amp with a non-inductive load at 28 v, dc, or 10 amp at 115 v, ac. The Class R switch is normally closed and opens on decreasing pressures. The Class G switch is normally open and closes on decreasing pressure. The control measures $3\frac{5}{32}$ x $2\frac{13}{32}$ x $1\frac{5}{32}$ in. United Electric Controls Co., 85 School St., Watertown, Mass.

For more information—
Circle 72, inside back cover



Converts D-c Measurement To Air Output

Electrical measurements of such process variables as temperature, speed, power and ph are converted into a proportional 3 to 15 psi pneumatic output and transmitted to graphic panel receivers by a pneumatic transmitter. Easily mounted on the back of a control panel, the transmitter receives a millivolt signal from the measuring element (thermocouple, tachometer), converts it into a proportional 2000 cps a-c voltage, amplifies and filters the signal, and feeds it to a phase detector circuit. The resulting d-c output is passed through a temperature-stable resistor and a trans-

You can SAVE UP TO 40% —on Controls

There *is* a better way to specify and buy the temperature, pressure, vacuum, liquid level and humidity controls that go into your equipment. A unique plan offered by Honeywell puts an end to hit-or-miss buying . . . reduces inventories . . . simplifies purchasing . . . and can save you up to 40 per cent in total controls costs.

All these advantages are yours, with the—

★ HONEYWELL CONTROLS PURCHASE PLAN

It's economical—because you buy on planned schedules that give you the benefit of most advantageous prices.

It's convenient—because you receive shipments at a rate which is geared to your own usage. Consolidation of purchases simplifies your stocking problems, too.

It's simple—gives you the advantages of a single responsibility. Whatever your application, you'll find the more than 7000 different Honeywell controls include the type you require.

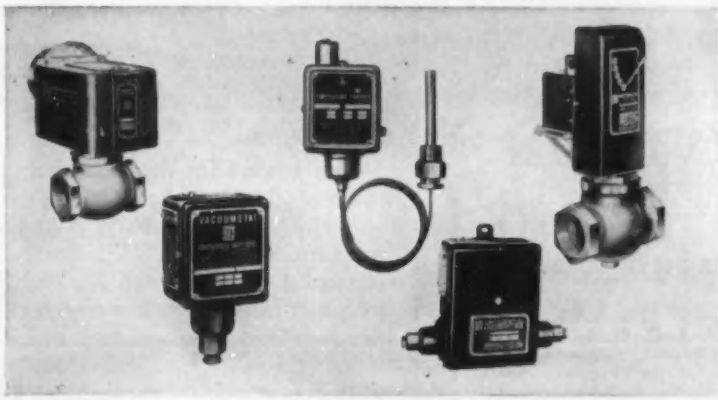
You'll profit, too, by the high quality and nation-wide service that represent exclusive plus values in every Honeywell control.

We'll be glad to give full details; just fill in and return the coupon.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario. *Also manufacturers of a complete line of precision measuring, recording and controlling instruments.*

MINNEAPOLIS **Honeywell**

First in Controls



Industrial Division
Minneapolis-Honeywell Regulator Co.
Wayne and Windrim Aves., Philadelphia 44, Pa.

☐ Please send me your catalog on Honeywell Controls.

☐ I'd like a Honeywell sales engineer to discuss how the Honeywell Controls Purchase Plan can be applied to my control purchases.

*Name*_____

*Title*_____

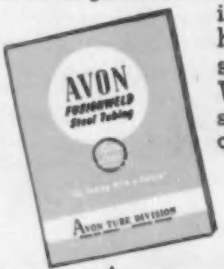
*Company*_____

*Address*_____

LET US QUOTE ON YOUR TUBING AND FABRICATION NEEDS

Avon single wall steel tubing is successfully supplanting other types of tubing—aluminum, brass, copper and steel—with equal or improved reliability of performance and really impressive economies. Avon's High Frequency Fusionweld process insures a much higher degree of tensile strength, greater resistance to vibration and fatigue, extreme ductility, plus greatly improved adaptability in producing the most critical tube forms—such as beading, bending, coiling, flaring, knurling, slotting, piercing, threading and swaging without cracking, tearing or checking.

Avon engineers can assist with your tubing problems and help point up cost saving advantages. Why not write, or submit blueprints for quotations.



⅛" O.D. to ¾" O.D.
PLAIN OR TERNE COATED

A few of the hundreds of Fusionweld Tubing applications

AUTOMOTIVE
Gas lines & vents
Brake lines
Hydraulic window & seat lifts
Chassis tubes
Radiator overflow
Choke controls
Oil return lines
Dip stick tubes
Oiler tubes
Automatic transmission

FARM EQUIPMENT
Hydraulic lifting devices
Support tubes
Lubrication lines
Fuel lines
Fuel manifolds

ELECTRICAL
Ceiling & wall fixtures
Lamp tubes
Heating elements
Radio & TV antennae

HEATING
Oil & gas lines
Pilot tubes
Flash tubes
Pot burner tubes
Fuel tank tubes

TOYS—FURNITURE
Scooter & wagon parts
Spacers
Pop guns
Bicycle parts
Mechanical toys
Tables
Chairs
Swings
Baby carriages, cribs, car seats and beds

MISCELLANEOUS
Umbrellas
Display boards
Panels
Conveyor oil lines
Lawn mower handles
Hose reels

AVON TUBE DIVISION

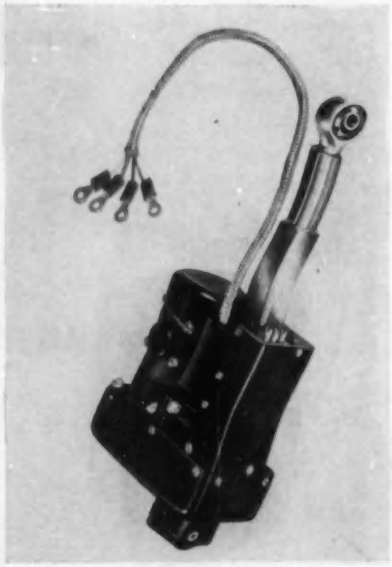
HIGBIE MANUFACTURING CO.

ROCHESTER MICHIGAN

ducer winding, connected in series. Current through the resistor is said to provide inverse feedback equal to 99.8 per cent of the input signal.

The standard transmitter provides spans as narrow as 10 mv and as wide as 60 mv. Instrument sensitivity is 1/20 of 1 per cent of scale; accuracy is 1 per cent of scale, repeatable to ¼ per cent. Foxboro Co., Foxboro, Mass.

For more information—
Circle 73, inside back cover



Smaller, Lighter Linear Actuator

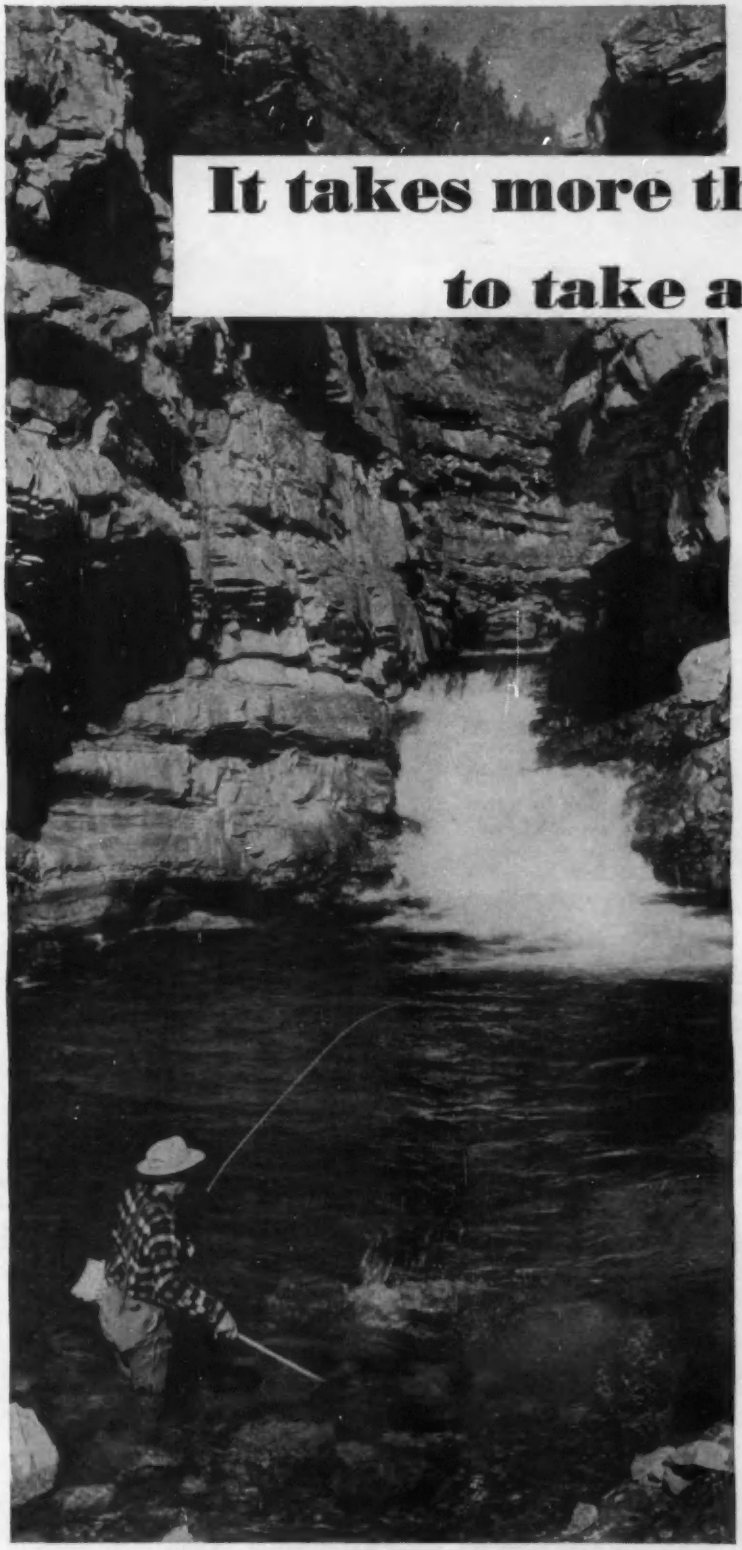
The entire device weighs 1.40 lb, an important consideration in the weight-conscious aircraft industry. Each gear is made of steel with a yield strength above 180,000 psi. The rate may be changed from 1.6 to 30.0 in. per min in convenient steps at any time, by merely substituting two gears. John Oster Mfg. Co., 1 Main St., Racine, Wis.

For more information—
Circle 74, inside back cover

Panel and Socket Mounting Thyratrons

Two xenon-filled thyratrons having identical electrical characteristics can be used for motor control and ignitor firing circuits. The EL C4J is designed for socket mounting, the EL C4J/F for panel mounting wherever conventional sockets might not be desirable.

Rating is 4 amp d-c continuous av-



It takes more than a good fly to take a trout

Even the costliest fishing gear, the finest rod, the best reel and the prettiest fly can't assure catching a wily trout. It's the experience behind these accessories, that fills the creel.

There's no substitute for "Know-How" and that's particularly true in adapting metal treating chemicals to established production. It can't be gotten out of books, through black magic or out of a crystal ball. Only years of active contact, with actual manufacturing procedures, can be depended upon for satisfactory solutions of the metal protecting problems constantly confronting manufacturers.

ACP offers ideal products for removing and preventing rust on metal, chemicals to bond paint to steel, zinc, and aluminum, and pickling acid inhibitors. In addition, ACP furnishes a free service of an organization of technical experts with over 40 years' experience in solving metal preservation problems for the largest as well as the smallest operation.

Rely on service backed by experience. You are obligated in no way by consulting our technical staff.

Write or call for further information on ACP chemicals for metal protection.

Since 1914, Pioneering Research and Development in Metal Protection

CHEMICALS ACP PROCESSES

American Chemical Paint Company

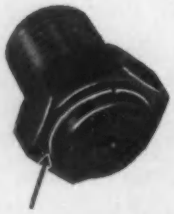
CHEMICALS ACP PROCESSES

AMBLER, PENNA.

DETROIT, MICH. NILES, CALIF. WINDSOR, ONT.

Only 4 seconds to make this oil and air-tight joint with EASY-FLO 45

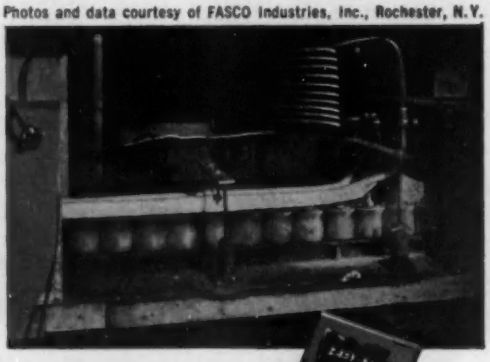
HERE'S A TYPICAL EXAMPLE of the reasons why the EASY-FLO low-temperature silver brazing alloys are so extensively used in the automotive and aviation industries. It shows how easy it is to get fast production of high-strength liquid and gas-tight joints with these alloys. And note that no brazing skill is needed. All this adds up to metal joining costs that are surprisingly low.



EASY-FLO 45 WIRE RING

The unit is a pressure switch which is part of the Studebaker anti-creep "hill holding" device. The job is brazing the threaded spud into the cover. Operator sets covers in cylindrical holders on an endless chain and in the covers she places the spuds, each one with a ring of EASY-FLO 45 preplaced. Assemblies pass thru an induction heating coil (below) – 14 a minute.

Photos and data courtesy of FASCO Industries, Inc., Rochester, N.Y.



Expert brazing production know-how at your service

Without obligating you in any way, we'll send a field service engineer to help you work out similar fast, economical production set-ups on your brazing jobs. Just write and say when you would like him to call.

FOR EASY-FLO FACTS IN PRINT . . .
write for Bulletin 20.

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

DISTRIBUTORS IN PRINCIPAL CITIES

OFFICES and PLANTS
BRIDGEPORT, CONN.
PROVIDENCE, R. I.
CHICAGO, ILL.
CLEVELAND, OHIO
DETROIT, MICH.
LOS ANGELES, CALIF.
TORONTO, CANADA
MONTREAL, CANADA

erage anode current; 30 amp oscillograph peak current with maximum peak forward and peak inverse of 900 v. The average arc drop is 12 v and heating time is 60 sec. Electrons, Inc., 127 Sussex Ave., Newark 3, N. J.

For more information—
Circle 75, inside back cover

Controls Pressures To 250 Psi

For use primarily with boilers up to 250 psi, but applicable for other types of liquid level regulation, this control is available in several body types. Basically it is a twin-switch, float-operated control. When used for boiler service it can start and stop a boiler feed pump, interrupt current to burner if water in boiler for any reason drops to emergency low level, close circuit to alarm if water in boiler drops to emergency level. Switching action is provided by permanent magnets mounted with like poles facing each other, so they act to repel each other. Magnets can be sealed from each other, but they will still provide a positive action for both the opening and the closing

Pyramiding Design Talents

with MADISON-KIPP zinc and aluminum die castings

Talented product designers are expert specialists in a given field. When such a product designer couples his knowledge with that of the seasoned and skilled Madison-Kipp die casting engineers, there is in effect a pyramiding of talents that is often extremely effective in getting maximum results.

In the companion parts here illustrated the advantages of the die casting process were utilized in full measure by such cooperative effort.

Please clip this ad as a reminder to contact us when you have die casting requirements.

kipp

MADISON-KIPP CORPORATION
206 WAUBESA STREET • MADISON 10, WIS., U.S.A.

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

HOT OR COLD

from Drying Ovens to Ice Flakers

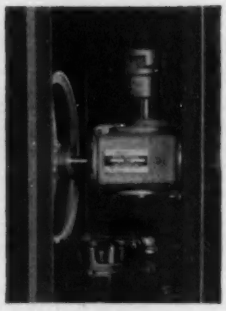
SAVE SPACE WITH

WINSMITH

SERIES "C" SPEED REDUCERS!

For *every* speed reducer application where space is at a premium, you'll put a premium on the new Winsmith Series "C" Speed Reducers. With this series, Winsmith achieves stepped-up horsepower and torque output without increase in overall size. Pricewise, this means that the "C" Series Reducer gives you more value than ever offered for your horsepower dollar.

The streamlined Scotsman Ice Flaker, manufactured by the American Gas Machine Company, is an example of how one manufacturer uses Series "C" Reducers to make every inch of space count. Because of *compactness*, the model "CT" reducer has been selected for use on the complete Scotsman Line. And, equally important, — *trouble-free operation* — is another reason the American Gas Machine Company gives for selecting this series!



This view of the mounting arrangement in the Scotsman Ice Flaker, shows the 10" pulley attached to the high speed shaft of the reducer.

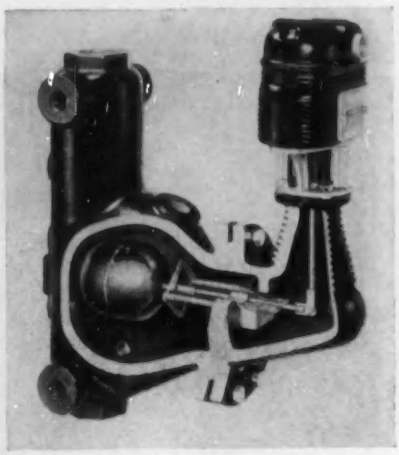
Driven by a ¼ hp motor at 1725 rpm, with a reduction ratio of 49 to 1, these "CT" reducers are helping to build a splendid reputation for Scotsman Ice Flakers in thousands of restaurants, hotels, hospitals and institutions throughout the country.

Whatever your products may be — from drying ovens to ice flakers — if you're designing for more streamlined appearance, or, if you're aiming at reducing component size without sacrificing performance, then you should get the complete facts on the Winsmith Series "C" Reducers. Write today for Bulletin HW-654.

WINSMITH, INC.
111 Eaton Street
Springville (Erie County), N. Y.

WINSMITH SPEED REDUCERS

...a single source for the most complete line of speed reducers within the range of 1/100 h.p. to 85 h.p. in ratios of 1.1:1 to 50,000:1



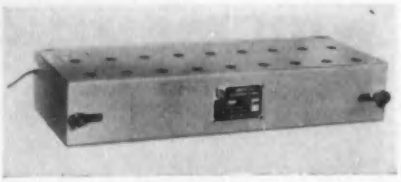
of the switches. McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

For more information—
Circle 76, inside back cover

Electric Circuit Regulator

This direct-action, finger-type control for power applications has a finger load rating of 720 w. Available types include a model with d-c operating coil, another for single-phase ac, a third for three-phase ac. These last two have internal rectifiers. Electric Regulator Corp., 604 Pearl St., Norwalk, Conn.

For more information—
Circle 77, inside back cover



Data Transmission Terminal

This audio frequency shift terminal is for use in the transmission and frequency multiplexing of telemetering, supervisory control and telegraph signals. The equipment is relatively insensitive to noise and amplitude variations of the communication link and is directly applicable to both frequency and time duration type telemetering systems. When used in conjunction with telephone dials, stepping switches or relay pyramids, it is ideally suited for remote control functions.

In the voice frequency band, 23

Changing details of power-plant design on a Kodagraph Autopositive Paper print saves hours of redrafting

Toledo Edison Company reports on its use of Autopositive—

"One saving after another since 1947"

Shortly after Kodagraph Autopositive Paper was introduced, the Toledo Edison Company, Toledo, Ohio, began exploring its possibilities for engineering drawing reproduction.

Here was a revolutionary photographic intermediate paper which produced positives directly from positives—no negative step. It could be exposed in standard print-making equipment . . . processed in standard photographic solutions. *Entire operation in ordinary room light, too.* Jobs which had been difficult and costly became easy and economical—Kodagraph Autopositive Paper costs only a few cents a square foot. Some typical savings at Toledo Edison *which you can duplicate* are listed here.

☐ **Old prints and intermediates reclaimed.** No time lost retracing. Autopositive Paper strengthens weak line detail, cleans up backgrounds. Toledo Edison now can get intermediates which have dense photographic black lines on an evenly translucent paper base. *Original quality or better!*

☐ **Opaque originals no problem.** Many of Toledo Edison's forms, charts, operating maps, etc., are on opaque stock—some two-sided. Data is added to these in pencil or by typewriter. Then Autopositive reproductions are made and used to produce the direct-process prints needed for distribution. The 1954 Annual Budget, for example, was reproduced in this manner. *Autopositive saves time and dollars for all departments.*

☐ **Print-making simplified.** Toledo Edison runs Autopositive intermediates at uniform, practical speeds in its direct-process machine . . . gets sharp prints time after time. *Autopositive lines do not smear, smudge, or lose density.*

☐ **Drafting shortcuts.** An Autopositive print is made of a drawing which has to be altered. The obsolete detail is eradicated or scissored out, and another Autopositive is made. New design is then added, and the job is completed without redrafting.

☐ **Photo-lasting file copies.** Toledo Edison also finds that Autopositive intermediates will not turn yellow or become brittle . . . are ready to produce sharp, legible prints whenever needed.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

Shows all the ways you can save with Kodagraph Autopositive Paper.

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y.
Gentlemen: Please send me a copy of "Modern Drawing and Document Reproduction."

Name _____ Position _____

Company _____ Street _____

City _____ Zone ____ State _____

15

Kodak
TRADE-MARK

SILICONE RUBBER *Custom-Compounded* TO MEET *Your Own* SPECIFICATIONS

Acushnet's Custom-Compounding Method is a notable simplification in the processing of Silicone Rubber, the remarkable material that resists temperature extremes from +600°F to −140°F.

By using the versatile Silicone *gums*, we formulate our own compound to obtain the specific property or properties required for each individual application. This eliminates large inventories and involved "doctoring" of standard pre-mixed stocks.

Many times, a lower cost formulation can be used which will perform in the particular application as well or better than any available pre-mixed stocks.

Each order can now be tailor-made to fit the customers' own specifications or requirements. As a result, production time is shortened, better product performance is obtained, and in many applications the cost is reduced.

When customers still specify a standard stock suitable for application we gladly produce the required part.

Acushnet

Send for a copy of the Silicone Rubber parts brochure illustrated above — an interesting, informative compilation of Silicone Rubber Data, with illustrations and descriptions of typical and unusual applications.

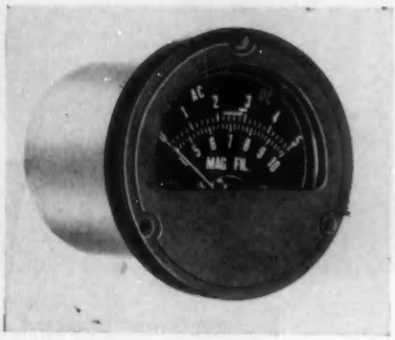
Acushnet Rubber Data Handbook also available on request.

Address all communications to 768 Belleville Ave., New Bedford, Mass.

ACUSHNET PROCESS COMPANY

channels from 300 to 3200 cps are available for telemetering and supervisory control. Special filters are available in the voice band from 765 to 3100 cps, which will provide for 14 channels of telegraph at printing speeds of 100 words per minute. The complete terminal measures 3½ x 19 x 8 in. for mounting in a standard relay rack. Radio Frequency Laboratories, Inc., Powerville Road, Boonton 33, N. J.

For more information—
Circle 78, inside back cover



Multiple Scale Meters

These multiple-scale meters provide up to five scales in all sensitivities. The units are in durable, space-saving 2½ in. sealed metal housings with die-cast aluminum mounting flanges. Screw-lock terminal connectors provide quick installation and disconnect for replacement or service. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 79, inside back cover

Panel Instrument Initiates Control

An automatic, all-electrical device for initiating action when a predetermined value is reached picks up the signal from the instrument pointer. This eliminates the disadvantages of mechanical contacts, according to the manufacturer. Because control of important variables is automatic, human errors and expenses are reduced.

Typical applications for the new instrument are: 1) to sound an alarm when the controlled temperature reaches a critical value; 2) to initiate control to contain cycles per second within a specified range; 3) to shut

First in performance for automatic muscle jobs like these...

T-J

Spacemaker CYLINDERS

OFF SHELF DELIVERY

PUSH

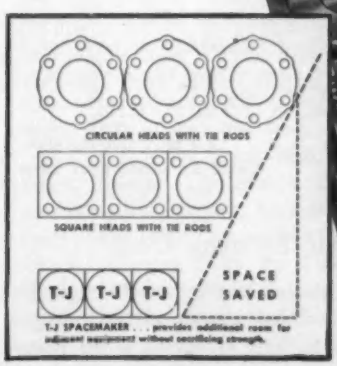
PULL

LIFT

- OIL pressure to 750—AIR to 200 P.S.I.
- New Compact Design . . . Saves up to 40% Space
- Proven Performance . . . with Extra High Safety Factor
- Super Cushion Flexible Seals for Air . . . New Self-Aligning Adjustable Oil Cushion
- Hard Chrome Plated Bodies and Piston Rods
- The Only Cylinders with all the Extras as Standard

T-J Spacemaker Cylinders get first call for an ever-widening range of power movement jobs in industry today—because they're so advanced in design . . . so efficient and dependable in performance. Wide selection of styles and capacities. Check your needs now! Send for bulletin SM-454-2. The Tomkins-Johnson Co. Jackson, Mich.

Raise
Lock
Brake
Press
Spin
Turn
Grind
Weld
Lower
Squeeze
Bend
Coin
Saw
Tap
Index
Braze
Open
Time
Blank
Cut
Broach
Drill
Sequence
Close
Snub
Form
Pierce
Feed
Mill
Convey
etc.


CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
T-J
T-J
T-J
SPACE SAVED
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

T-J TOMKINS-JOHNSON

RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

Member of the National Fluid Power Association

BUILD YOUR BUSINESS ALONG THESE LINES

with BIJUR Automatic Lubrication

By incorporating the Bijur System into your designs, you can offer substantial operating economies which progressive users now demand. For example, in the metalworking field 75% of machinery users prefer "built-in" automatic lubrication on the machines they buy.

Costly hand lubrication is eliminated.

Production time is saved because machines are oiled while in operation.

Bijur Automatic Lubrication is the best friend a bearing ever had. Every bearing is automatically fed a metered shot of oil at predetermined intervals.

Inaccessible bearings that require regular lubrication are never neglected.

There can be no problem of work spoilage or bearing headaches caused by over lubrication.

Leading machine builders have standardized on Bijur for a quarter of a century. Bijur puts the accent on engineering design – to satisfy the specific requirements of your machines.

Our engineers can show you how to build increased dependability into your machines, whether they are in production or still on the board.

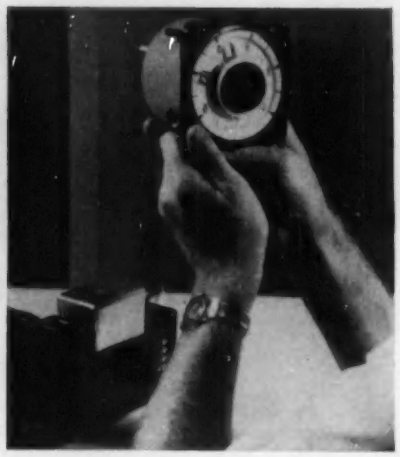
0-4

Write for literature and engineering data.

8370

BIJUR
LUBRICATING CORPORATION
Rochelle Park, New Jersey

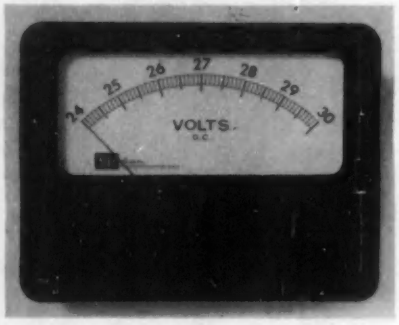
Pioneers in Automatic Lubrication



down equipment at a maximum vibration point; 4) to shut down machinery drawing more than normal power.

The new control instrument is suitable for one-set point or two-set point initiation. The load relay supplied is rated at 120v at 10 amp or 240v at 5 amp, single-pole, double-throw. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 80, inside back cover



Expanded Scale Voltmeters

These d-c voltmeters for panel mounting are said to be accurate to ½ per cent of input voltage. Standard base voltages range from 6.25 to 230 v, with span that can vary from 4 to 25 per cent of base voltage. Sizes: 2½ and 3½ in. round or square, 4½ in. round and 4 x 6 in. rectangular. Beckman Instruments, Inc., 220 Pasadena Ave., S. Pasadena, Calif.

For more information—
Circle 81, inside back cover

Electric Heating Unit

An electric-heating unit originally developed for use in electric ranges is said to have application on many

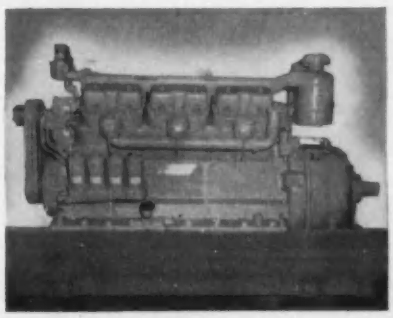
more flexibility
more wear life
more work

from new

CATERPILLAR

Torque Converter

Power Units . . .

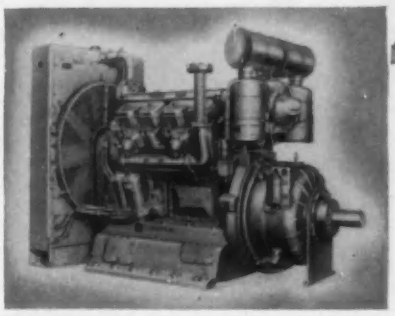


Caterpillar Torque Converter Power Unit — a Model D386 Cat Diesel working through Twin Disc Model CF Torque Converter.

FOR THE FIRST TIME, you can order any one of 6 Cat Diesel Engines *Torque Converter-equipped at the factory* . . . as complete Torque Converter Power Units, developed through design teamwork by Twin Disc and Caterpillar engineers.

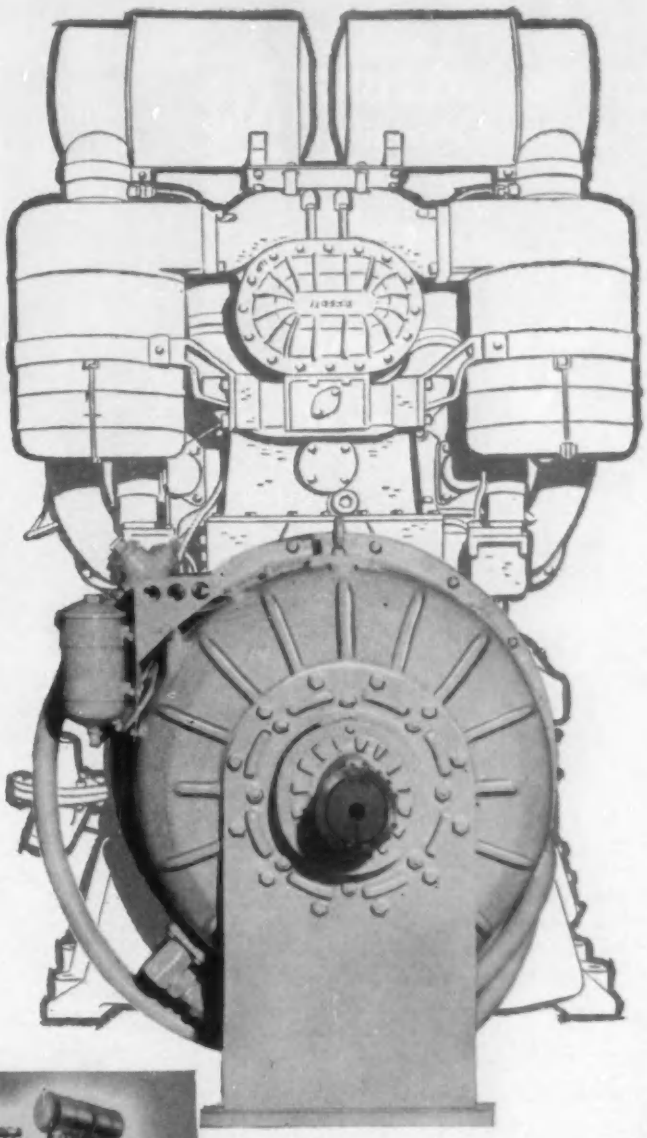
The result is *tremendous* performance—for power source and power linkage are *ideally* matched.

To give you a quick idea of how much Torque Converters mean to modern diesel power, here are a few facts you'll want to remember: on the new Cat Power Units, the Twin Disc Torque Converters • *match torque output automatically to the load* • *start loads smoothly* • *provide control of load movement without using clutch* • *prevent overloads from killing engine* • *permit hovering or holding under power* • *keep engines operating in maximum efficiency range at all times.*



Cat D375 Torque Converter Power Unit. Twin Disc Torque Converters are standard equipment.

Whether you're thinking about a new power unit or planning to replace a present one, find out how much *more* flexibility, *more* wear life, and *more work* you'll get *through Twin Disc Torque Converter Drive.* Contact your engine dealer . . . he'll give you the facts and figures.



Twelve different torque converter arrangements are available for six Caterpillar Diesels, up to 493 hp. Twin Disc also provides a wide choice of output shafts, for both in-line and side loads.

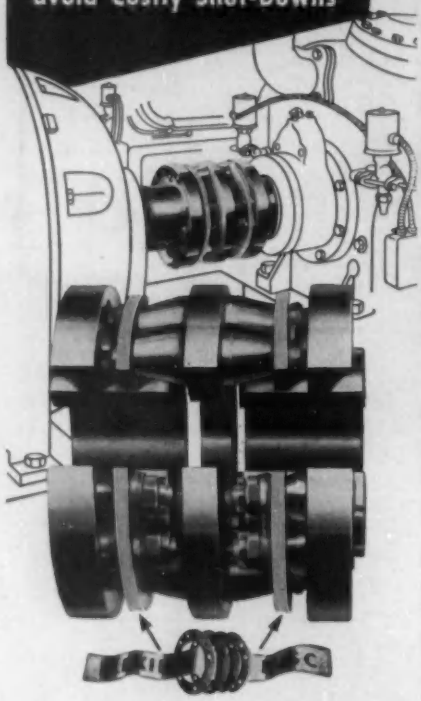
In the meantime, if you want more details on other Industrial-Type Torque Converters, write Twin Disc, Hydraulic Division, Rockford, Ill., and ask for Bulletin 135-D. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin; Hydraulic Division, Rockford, Illinois.

TWIN DISC

TWIN DISC

Torque Converters

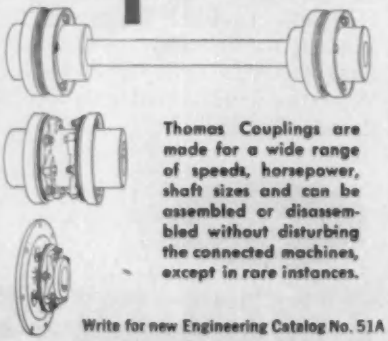
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

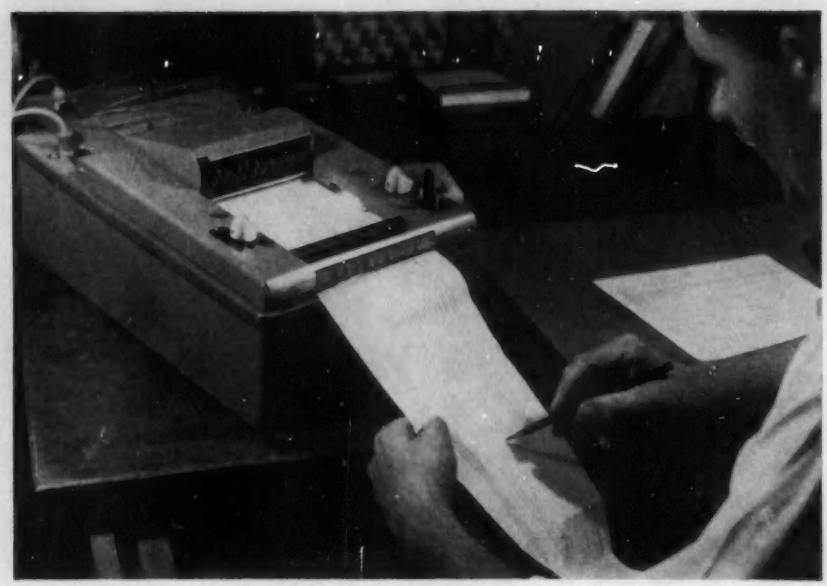
FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

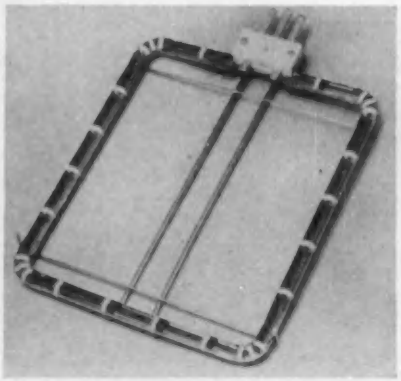
THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.



Thirty Channel Recorder

This 30-channel recorder has a capacity for monitoring the operation of up to 30 machines simultaneously, giving an instantaneous and permanent record of their operation, cycle and down time. It can also be used to record any type of motion, activity, or in any place that a simple, small switch can be attached. Two models of the recorder are available, Type 230A-6 with a speed of 1 and 6 in. of tape per min and Type 230A-12, with a speed of 1 and 12 in. of tape per min. Alden Electronic and Impulse Recording Equipment Co., Westboro, Mass.

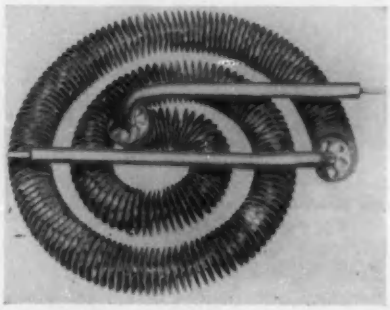
For more information—
Circle 83, inside back cover



other products, ranging from clothes dryers and room conditioners to space heaters and industrial ovens. These units use a continuous steel reflector attached on one side of the element to direct heat where it is wanted.

It is said that the unit's construction creates a turbulence of air which circulates freely to all parts of the oven, eliminating cold spots. Ferro Electric Products, Inc., Kirkland, Ill.

For more information—
Circle 82, inside back cover



Finned Electrical Heater

These heaters are made by brazing spirally-wound steel fins to a standard rod-type heating element. The heaters are formed to shape before the fins are attached. Spacing of the fins is optional, from four to eleven to the inch.

The new heaters are made with 0.312 in. tubing and 15/16 in. thick fins and may be used for all types of convection heating. Capacities range from 500 to 2,000 w.

A companion line is made with 0.540 in. tubing and 1-5/16-in. fins.

Specify **GITS *Unit* SEAL**

Result:

Economy

"Economy . . . counts not in savings but in selection."—*Edmund Burke*

Economy through Efficiency

Gits Unit Seal proves itself in dependable performance over a wide range of operating conditions—including extra-high speed, heat and pressure applications. Operation at peak efficiency always means dollars-and-cents savings.

Economy through Adaptability and Versatility

Gits Unit Seal fits many applications as a standardized item actually carried in stock. You harness the savings of mass production to your own specific needs. Gits Unit Seal already has wide application in the following fields: Washing Machines, Disposal Units, Gear Motors, Speed Reducers, Aircraft Turbine Pumps, Accessory Drive Units, Jet Propulsion Units, Electrical Power Equipment, Automotive Accessories, Business Machines, Standard and Special Machine Tools.

Economy through Long Life

Gits Unit Seal is designed for maximum life in any recommended application. Here's the real "proof of the pudding" in saving money.

Write Today For FREE Illustrated Brochure, or send us your seal problem. Our experienced engineering staff is at your service.

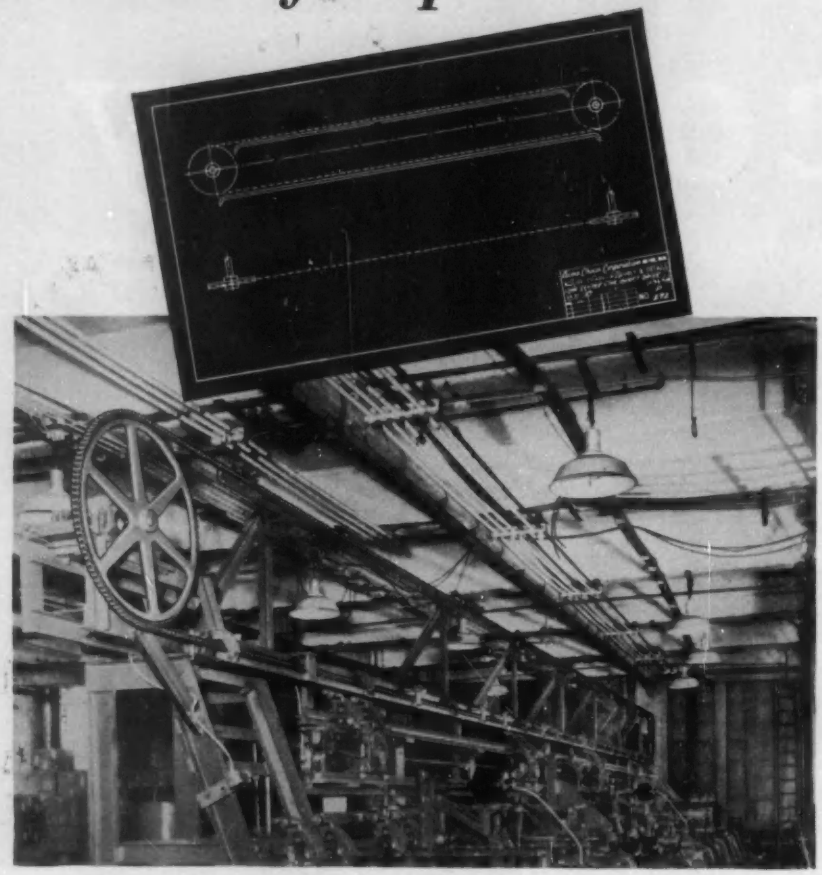
*Cartridge Seal . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1838 S. Kilbourn Avenue Chicago 23, Illinois

ACME

asks for problems



Acme engineers ask for *your* problems. Where roller chain is involved, Acme's engineers are willing to work along with your designers for the better, more efficient use of chain drive equipment. Don't hesitate to call on Acme whenever a problem arises.

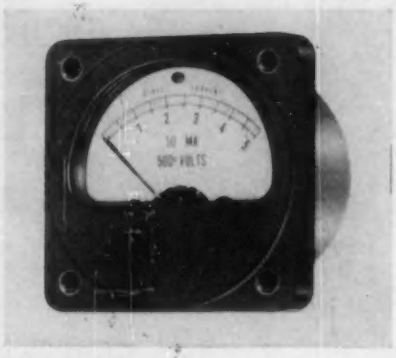
Write or call Holyoke JEfferson 2-9458

Write Dept. 1U for new illustrated 76 page catalog on use and application of roller chains and sprockets.

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

Capacities of this heavier line range from 1,000 to 10,000 w and can be used for 480-v operation, directly or in series. Ferrod Mfg. Co., 603 N. River St., Batavia, Ill.

For more information—
Circle 84, inside back cover



Ruggedized 2½ and 3½-In. Meters

These ruggedized meters withstand heavy duty military and ASA standard shock and vibration extremes under a wide range of temperature conditions as defined by Signal Corps specifications MIL-M-10304. Both ruggedized and sealed meters are calibrated for magnetic and non-magnetic panel mounting, and are available in a variety of special ranges, scale divisions, markings and color combinations. The instruments can be ordered with either front or rear scale illumination and a sealed front mounted zero adjuster. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

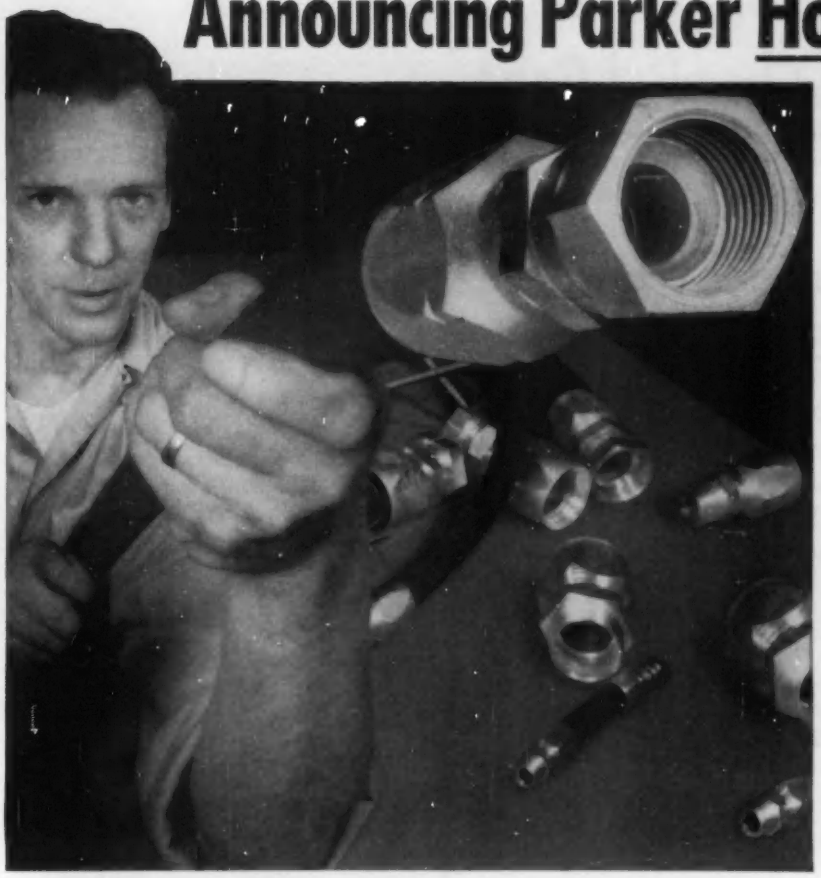
For more information—
Circle 85, inside back cover

Pressure Pilot

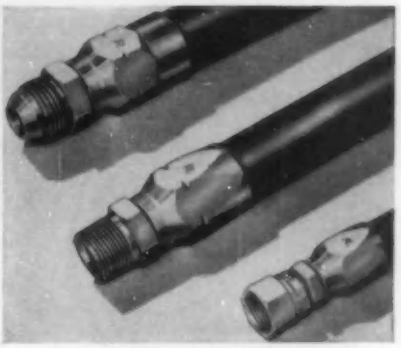
This unit has an integral gage for process pressure indication and provides direct setting of the control point on the same calibrated dial. It incorporates feedback proportional control or differential gap control with snap action over a 2 to 100 per cent band. The all metal power relay makes possible low nozzle pressures for linear response and output pressure up to 30 psi for positive valve action. The sapphire nozzle feed orifice is equipped with a push-button cleaner.

The cast aluminum case is 8½ x 8½ x 3¼ in. and has all connections

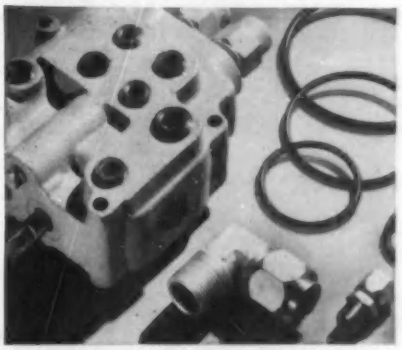
Announcing Parker Hoze-lok Fittings



S.A.E. Standards for hydraulic hose and fittings are fully met by Parker *Hoze-lok* fittings. See S.A.E. Handbook pages 725 to 730. Or, mail coupon for reprint.



3 styles: for cotton-covered or rubber-covered single-wire hose in medium pressure service; for rubber-covered, double-wire hose in high-pressure service.



What other Parker products interest you? *Triple-lok* flare tube fittings? *Ferulok* flareless tube fittings? New hydraulic control valves? Parker O-rings?

Use Parker Hoze-lok fittings for better performance, easier make-up, greater re-usability and economy

New Parker *Hoze-lok* fittings and hose assemblies, for medium and high-pressure hydraulic service, offer longer, trouble-free performance. The deep socket recesses provide an unusually large gripping area. Fittings won't pull out.

Hoze-lok conforms to S.A.E. Hydraulic Hose and Fittings Standards and to hose fitting specifications of J.I.C. Hydraulic Standards.

These new fittings make up easier . . . saving time and temper of assemblers. Socket thread is larger than braid diameter, making it easier to insert the hose end into the socket. Contour of the socket provides greater wrench clearance at hex of nipple.

Greater re-usability of *Hoze-lok* fittings cuts costs. Parts of old hose lines can be salvaged, fittings detached and re-used. You don't need large inventories—just a small stock of bulk hose and *Hoze-lok* fittings.

Hoze-lok fittings are augmented by *Triple-lok* (tube fitting) connecting adapters. Mail the coupon for *Hoze-lok* Catalog No. 4400.

TUBE AND HOSE FITTINGS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

TUBE AND HOSE FITTINGS DIVISION
Section 409-L
The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

☐ Please send *Hoze-lok* Catalog 4400
☐ Reprint of S.A.E. Standards Bulletin 4405B1

Name_____ Title_____
Company_____
Address_____
City_____ State_____

Parker

Hydraulic and fluid system components

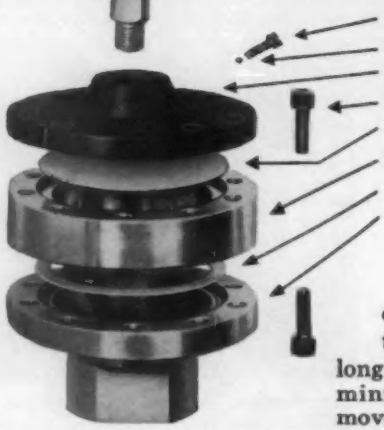
an ACCO product

Helicoid Chemical Gage

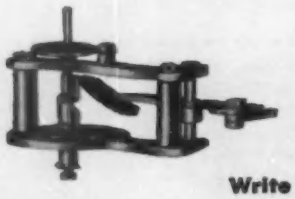
Gages for corrosive chemicals and liquids up to 5000 p.s.i.

• Here's an accurate pressure gage for chemicals and other viscous liquids which might corrode or clog the Bourdon Tube. It registers working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. Guaranteed accuracy plus or minus 1%. A single diaphragm seals off objectionable substances from the indicating gage. This gage is filled completely with specific inert liquids and pressure is transmitted directly to the indicating gage through deflection of the sealing diaphragm.

FEATURES



• HELICOID GAGES cost less in the long run because they give long, trouble-free service with a minimum of maintenance. The movement is a simple cam and roller design that does not have any gear teeth to wear out. It has been tested and proved in years of hard service.



Only Helicoid Pressure Gages Have the Helicoid Movement

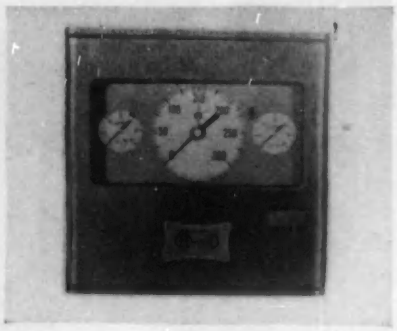
Write for Catalog Today

ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

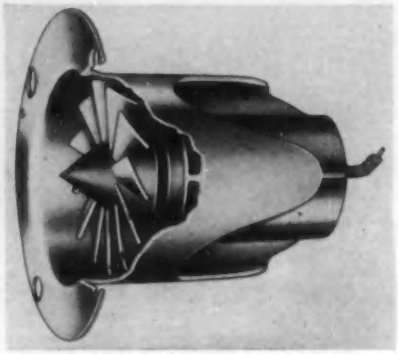
929-D Connecticut Avenue • Bridgeport 2, Connecticut

Pressure • Vacuum • Compound



on the left side, rear. It can be surface, flush or valve mounted. Bourdon elements range from 0 to 15 psi to 0 to 10,000 psi. Hammel-Dahl Co., 175 Post Road, Providence 5, R. I.

For more information—
Circle 86, inside back cover



Miniature Axial Flow Blower

The blower body is 2 in. dia by 3 in. long and produces 60 cu ft of free air per minute at less than 1 amp. The blower motor is powered by either d-c or 400-cycle a-c power and complies with all military specifications. Air Equipment Co., 2248 E. 37 St., Los Angeles, Calif.

For more information—
Circle 87, inside back cover

Liquid-Cooled Germanium Power Rectifier

This 35 kw germanium power rectifier is a three-phase bridge unit, rated for a maximum of 450 amp d-c continuous output. It can be supplied for input voltages of 26, 36, 52 and 66 v rms, max.

The Type 53-0075-0 has a volume of approximately 220 cu in., as compared to 1650 cu in. for a comparable selenium unit (fan-cooled) and 14,000

THE NEW CUTLER-HAMMER LINE

OF HEAVY DUTY, OILTIGHT

Pushbuttons, Selector Switches and Lights

The new Cutler-Hammer Pushbutton with double pole contact block that measures only 1 3/32" in depth.

The new Cutler-Hammer Indicating Light with separate winding transformer that measures only 1 9/32" in depth.

New shallow-depth contact blocks; greater freedom of circuit arrangements; better design; better appearance; better performance. Get them first, get them fast, get them *now*.

Once again the name Cutler-Hammer companions great achievement . . . an amazing and unique new line of heavy duty, oiltight pushbuttons, selector switches and indicating lights. There is nothing to compare with it. The feature that stands out above all is the new basic working unit, the contact block—and its counterpart for the indicating lights, the transformer or resistor. *THIS NEW CONTACT BLOCK MEASURES ONLY 1-3/32" IN DEPTH BEHIND THE MOUNTING PANEL.* A fact of amazing consequence for the vast majority of pushbutton users.

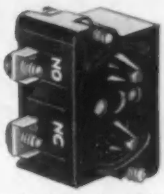
Of even greater consequence is the greater degree of circuit flexibility this new design provides. With its contacts set side by side, "in parallel," electrically isolated from one another . . . *you can apply one voltage on one set, a different voltage on the other. Or you can impress alternating current on one and direct current on the other.* Each pair of contacts has its own actuating plunger; you can throw both simultaneously, or singly or in sequence.

And you can add contact block to contact block, one behind another, easily, simply, swiftly, giving you virtually unlimited circuit possibilities.

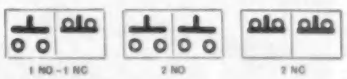
There is a complete range of operators: standard or extended length pushbuttons, with regular or mushroom head; selector switches providing maintained contact or momentary contact with spring return in either or both positions; key operators providing in addition momentary contact that becomes maintained on key withdrawal. Pushbuttons available in 5 colors. All operators are chrome-plated for lasting beauty. Indicating lights have new wide-visibility lenses proved by light-meter reading to be most visible of all from any angle. Lights are available with resistor or separate winding transformer. Transformer type with 6-volt bayonet lamp provides multiplied lamp life where shock and vibration prevail.

These and many other features are fully described and illustrated in a bulletin just published. Write for it today or see the complete line at your nearest authorized C-H distributor. CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

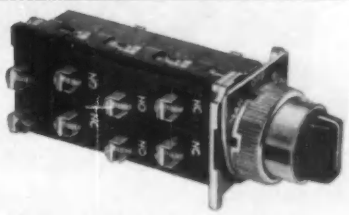
CUTLER-HAMMER
MOTOR CONTROL
C-H



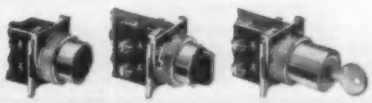
New shallow-depth contact block has electrically isolated contacts, allows different voltage or different current on each pair of contacts.



Three separate contact blocks available; with 1 NO and 1 NC contact; 2 NO contacts; or 2 NC contacts.



Double pole contact blocks mount easily one behind another to provide unlimited circuit combinations.



Every type of operator: pushbutton, selector switch and key operator.

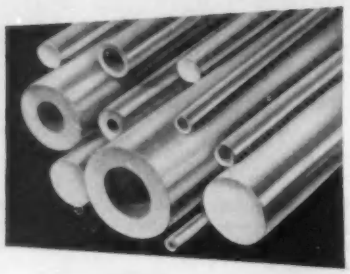
TEFLON*

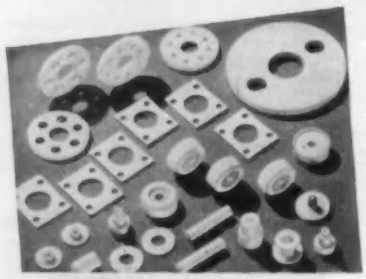
SHEET....ROD....

TUBING....MOLDED OR MACHINED PARTS?

YOU CAN GET JUST WHAT YOU WANT

from JOHN CRANE





TEFLON *DuPont trademark*

Advantages:

CHEMICAL—Completely inert

ELECTRICAL—Extremely low power factor
Very high dielectric strength

THERMAL—Temperature range
−300°F. to +500°F.

MECHANICAL—Strong, flexible
Weather resistant

LOWEST COEFFICIENT OF FRICTION

ABSOLUTELY NON-STICK

"Made of Teflon by JOHN CRANE" has become practically a standard specification for parts and components subject to severe electrical, corrosive, thermal, mechanical or atmospheric abuse. Whatever your requirements in Teflon . . . sheet, rod, tubing, packings, gaskets, bellows, insulators, sealing discs or non-stick parts . . . "John Crane" can supply them!

In addition, you get these important *plus* factors: complete uniformity throughout, high density control, freedom from flaws and rigid adherence to your specifications.

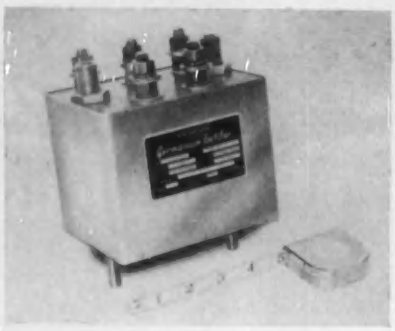
"John Crane's" complete fabrication facilities assure you prompt delivery on *exactly* what you want—no compromise. If you have an entirely new requirement, no standard design or procedure—"John Crane's" laboratory facilities, know how, research and engineering experience go to work on *your particular* need.

Now is a good time to put "John Crane" to test. Contact Crane Packing Company today.

Crane Packing Co.,
1845 Cuyler Ave.,
Chicago 13, Illinois

In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL "PROGRESS"



cu in. for a copper oxide unit (fan-cooled). This new unit requires liquid coolant (such as water, oil) at a maximum inlet temperature of 25 C and a volume of ½ gpm, min. International Rectifier Corp., El Segundo, Calif.

For more information—
Circle 88, inside back cover

Miniature 1 In. Panel Meter

This miniaturized unit uses the external pivot D'Arsonval movement. Scale windows and terminals are watertight. An O-ring gasket and locknut are provided for shockproof mounting.

This new sealed meter can be ordered with white, black or luminous markings on white or black scale background, and a choice of colors for the pointer. The round mounting flange measures 1-¼ in. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

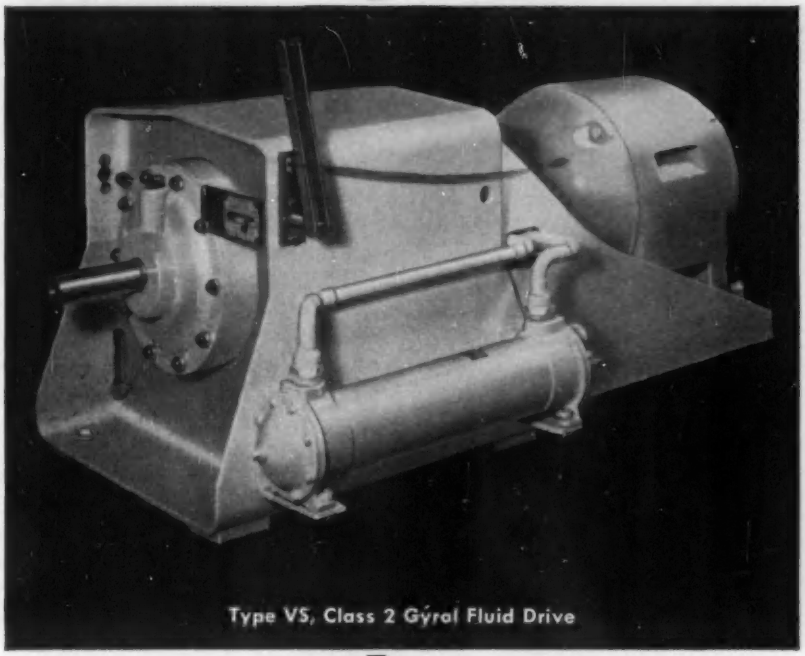
For more information—
Circle 89, inside back cover

Porous Stainless Steel Snubbers

This snubber was designed specifically to meet the needs of the aircraft industry. The snubbing element, a disc of Type 316 porous stainless steel, is assembled into an AN815-4

American Blower Gýrol Fluid Drives are

Mighty Popular with Equipment Operators



Type VS, Class 2 Gýrol Fluid Drive

Here's why:

It's the flexibility and simplicity of Gýrol Fluid Drives that make them popular with equipment operators. No special motors or complicated starting controls are needed (saving power and maintenance costs); yet, Gýrol Fluid Drives offer operators such welcome features as adjustable, stepless speed control over a wide speed range, overload protection, smooth acceleration and complete shock absorption. These features reduce operator fatigue and strain because equipment operation is simpler and quieter.

You can get complete data on Gýrol Fluid Drives from your nearest American Blower Branch Office.

Typical Applications

PUMPS, AGITATORS, MIXERS
CONVEYORS, CABLE & ROPE MACH'Y
FANS AND BLOWERS
CENTRIFUGAL COMPRESSORS,
PAPER AND PRINTING MACH'Y
TEXTILE MACH'Y

Advantages of using Fluid Drive on Conveyors

Besides providing smooth acceleration, Gýrol Fluid Drive is an excellent means of adjusting conveyor speeds to suit process or production demands. With manual control, the conveyor can be operated at speeds well below normal speed, can even be stopped completely without shutting down motor. If conveyor jams, the Fluid Drive acts as automatic shearpin since output shaft stalls until jam is cleared.

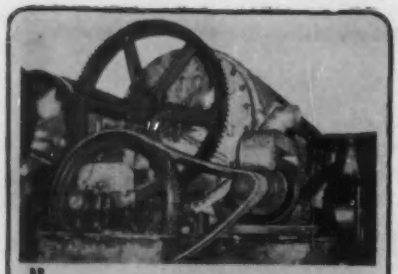
American Blower products serve industry

- AIR CONDITIONING, HEATING, VENTILATING EQUIPMENT
- MECHANICAL DRAFT EQUIPMENT
- INDUSTRIAL FANS AND BLOWERS
- CENTRIFUGAL COMPRESSORS
- GÝROL FLUID DRIVES
- DUST COLLECTORS

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS



"THIS LUBRICANT INCREASED CHAIN LIFE 4 TIMES"

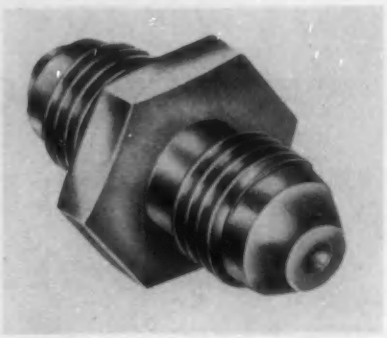
—says FASTERFAT, Division of National Sea Products Limited

"Two years ago we switched from the lubricant we were then using to your LUBRIPLATE, and we are pleased to inform you that we have had very excellent satisfaction from its use. High speed silent chains on the drives of our fish meal cookers, which were formerly worn out in about six months, are still in service after two years."

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

LUBRIPLATE is available in grease and fluid densities for every purpose... LUBRIPLATE H. D. S. MOTOR OIL meets today's exacting requirements for gasoline and diesel engines.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK"... a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.



fitting. The element is adjusted for use with any one type of material, such as hydraulic oils, aircraft fuels, air, gases.

Unlike single-orifice types, these snubbers expose a large porous surface, minimizing clogging in pressure gage service. Chemiquip Co., 460 W. Broadway, New York 12, N. Y.

For more information—
Circle 90, inside back cover

HYDRAULICS AND PNEUMATICS

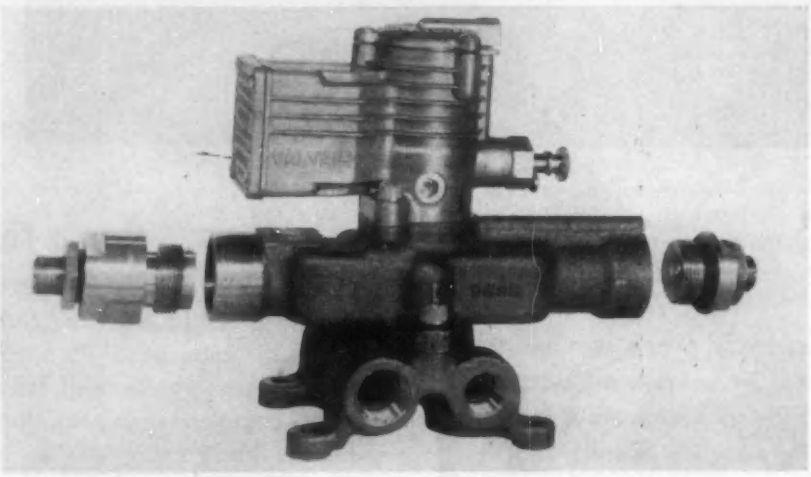
Speed Control Of Cylinders

Conventionally, control of the speed of a cylinder is accomplished by restricting the flow from the outlet side of the cylinder by means of a separate valve between the control valve and the cylinder. Two of these valves are required to control the cylinder speed in both directions. This new control accomplishes this restriction of flow through the main control valve, eliminating the separate flow control valves.

Control of the restriction is done by the addition of adjusting screws in the end caps which will restrict the stroke of the main stem of the valve and thus restrict the flow of cylinder exhaust air through the valve.

Sizes $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in. are now available. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

For more information—
Circle 91, inside back cover



Hydraulic or Pneumatic Pressure Regulator

Designed to accept a sudden pressure load, this regulator is said to have no limits as to practical industrial or experimental use. It can easily accept many thousands of pounds of pressure instantly, and quickly reduce that pressure to ounces where necessary. Once the desired adjustment is made, a precisely accurate flow of pressure is permanently maintained.

A non-corrosive brass cylinder and barrel contains a brass piston and two cadmium-plated steel precision springs. The entire unit, exclusive of gauge, is $1\frac{1}{2}$ in. wide x 3 in. long. Pipe con-

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 16

Dow Corning 44 Grease Reduces Bearing Failures

Like many basic components, bearings can cause costly problems if they're not properly lubricated. For example, the Century Fan and Ventilator Co., Stamford, Conn., was plagued with trouble calls until they began furnishing a tube of Dow Corning 44 Grease with each of their draft induction units for heating plants. They even included a gun in the supply kit to assure proper application of the grease. The results—new highs in product performance and customer satisfaction.

Designed to automatically supply the correct volume of air for combustion throughout the firing range, the Century draft inductor is a motor-driven fan with 12 backward curved blades enclosed in a sheet metal scroll mounted directly in the boiler breeching. The fan wheel rests on a heavy duty shaft supported by two ball bearing pillow blocks.

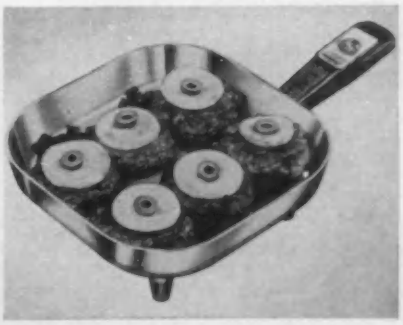
Because it is very close to the burner, the unit circulates air at temperatures as high as 650 F. Organic greases lubricating the bearings supporting the fan shaft dried out rapidly. Unless relubricated weekly, the fan was apt to slow down, become noisy, or stop altogether—and Century received another trouble call. Then, two years ago, Century switched to Dow Corning 44, recommending its application every 30 to 60 days. Today, the fans are giving top-rated performance and trouble calls have been practicaly eliminated! *No. 158*

SUNBEAM "FRYPAN": CASE HISTORY OF AN ADVANCED DESIGN MADE PRACTICAL BY DOW CORNING SILICONES

Ingenious design and resourceful use of materials is reflected in the Sunbeam Automatic Frypan, an attractive and original new household appliance, which combines the appeal of a built-in source of controlled heat with the convenience of easy, thorough washability.

These ideal features were made practical through use of Dow Corning silicones. The completely enclosed lead and thermocouple

(Continued pg. 2)



Silicone Fluid Improves Dashpot Timing Device

The nitrogen impact fishing jar developed by Houston Oil Field Materials, Inc., presents a new approach to the problem of loosening tools jammed in the depths of oil wells. On impact, old style jars shake and strain derricks and pipe strings. The new Homco unit eliminates wear and tear on equipment by concentrating all its 208 ton kick inside the jar attached to the jammed tool.

Another valuable feature of the new Homco jar is regulated impact time. By means of a unique dashpot timing device containing Dow Corning 200 Fluid, the hammer blow can be delayed while the jar is moved into a new position. By varying the quantity and viscosity of the silicone fluid, the impact time may be varied from a few seconds to half an hour.

Dow Corning 200 Fluid was selected as the dashpot oil after tests proved it to be the most heat-stable fluid available. Organic oils thin out rapidly when subjected to well temperatures and to the heat generated by successive impact blows. But Dow Corning 200 Fluid with its relatively flat viscosity-temperature slope, thins only slightly even after 10 to 15 hours' continuous operation. This change is so slight that it is more than compensated for by expansion of the metal parts and fittings. *No. 159*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . .

Silicone Foaming Powders produce heat-stable, noninflammable, easily machined, low density foam structures for electrical and thermal insulation. Supplied ready to use, they can be foamed in place and often cured in service. Recently published data sheet gives applications, properties and foaming characteristics. *No. 163*

Dow Corning 36 Emulsion is a completely new silicone mold lubricant. Much more stable than any comparable silicone emulsion, it gives molded parts superior surface finish. Its stability is attributable to an average particle size of less than 0.5 microns. At concentrations in the range of 1 part emulsion to 100-200 parts water, Dow Corning 36 Emulsion gives clean, easy release of rubber or plastic moldings and cast metal parts. *No. 164*

Sylkyd 1400 Varnish is a modified silicone dipping and impregnating varnish with thermal stability intermediate between present Class B and Class H materials. It is designed for use at the hottest spot temperature of 155 C specified for Class F insulation as listed in the International Standards and recognized in Europe. Moderately fast curing, it has good bond strength and excellent resistance to oils and solvents. *No. 165*

Dow Corning 6 Compound, a greaselike nonhardening, rust preventative in ferrous alloy metal parts in delicate mechanisms and fine instruments, provides excellent protection during long time indoor or outdoor storage. *No. 166*

"What's a Silicone?" is the title of a 32 page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 167*

Silicone products most widely used, are indexed by type of application, in the 1955 Reference Guide to Dow Corning Silicone Products. A brief but comprehensive 8-page summary is given of the properties and applications. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design, production and maintenance engineers. *No. 168*

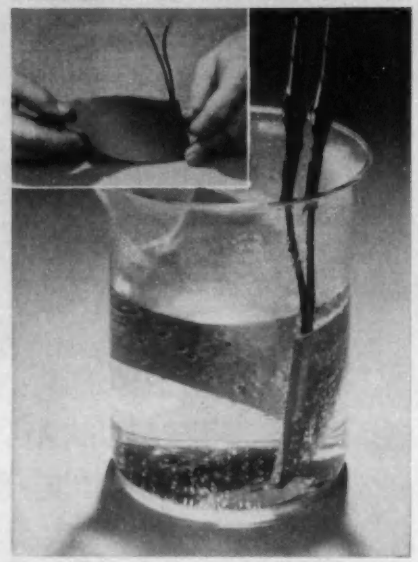
Silicone Insulation Expands Electric Valve Market

You can open new markets for electric machines and electronic devices simply by offering units insulated with Dow Corning silicones. That's been the experience of many manufacturers including the Atkomatic Valve Co., Inc., of Indianapolis.

The solenoid operated valves manufactured by Atkomatic have always been popular for use in inaccessible locations because of their fast, hammerless operation and remote controllability. Their application has been somewhat restricted, however, by the operating temperature limits of 180 F imposed by the organic insulating materials in the solenoid coils.

Atkomatic designers removed that temperature limitation and at the same time expanded their markets by developing a special series of solenoid coils insulated with heat-stable silicones. Capable of operating up to 450 F, the silicone insulated coils can be used on valves exposed to the most rugged high pressure steam service. They open up an important new market by making it possible to use solenoid operated valves in automatic control systems for general space heating and for production lines handling hot liquids. *No. 160*

Silastic Insulates, Protects Flexible Woven Heater Pad



Proof of the effectiveness of Silastic* encapsulation is found in the performance of this 115-volt flexible heater woven and insulated by the Haddam Manufacturing Co., Haddam, Connecticut, for a classified aircraft use. The combined thermal stability and conductivity of Silastic is so great that the heater will operate indefinitely at temperatures high enough to boil the water in which it is totally submerged. *No. 162*

*T.M. REG. U.S. PAT. OFF.

SUNBEAM "FRYPAN" *(Continued)*

wiring, for instance, is insulated with Silastic, the Dow Corning silicone rubber. Silicone-glass sleeving is also slipped over the wires to assure maximum dependability at operating temperatures in the range of 450 F. And the terminal block to which they are connected is a heat resistant silicone-glass laminate.

Although the Frypan may be almost totally immersed in water, the electrical connections at the base remain dry and easily accessible inside a terminal box sealed with molded Silastic. Extensive research and testing, including several thousand actual immersions, have proved that this gasket maintains a watertight seal even after prolonged exposure to temperatures in the range of 450 F. *No. 161*

Dow Corning Corporation, Dept. 8605, Midland, Michigan

Please send me: 158 159 160 161 162 163 164 165 166 167 168

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING CORPORATION
MIDLAND MICHIGAN

first in silicones
DOW CORNING SILICONES

ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

New...

for machine designers and users...

J-M brings you a

COMPLETE OIL SEAL REFERENCE MANUAL

Here, in one handy book, is everything you need to know about America's leading oil seals. In 28 pages, fully illustrated, J-M tells you how you can improve performance and cut costs with more effective sealing, longer lasting Clipper Seals.

There are detailed descriptions of all the latest standard seal designs including the new LPD and RPD . . . as well as those for special applications. Uses in petroleum, automotive, mining, earth-moving, aviation, iron and steel, machine tool and process industries are covered thoroughly.

Documented case histories tell how leading manufacturers have profited from the superior performance of Clipper Seals. Full use is made of every type of illustration for complete descriptions of important applications. Close-up photographs show how to install split Clipper Seals in limited space.

Learn how Clipper Seals' many advantages can cut costs for you . . . by simplifying design problems, speeding assembly and providing improved lubricant retention and dirt exclusion under all conditions. Write for free brochure PK-71A to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Johns-Manville CLIPPER SEALS

Johns-Manville, Box 60, New York 16, N. Y.
Please send me free copy of new Clipper Oil Seal Brochure (PK-71A)

Name_____ Title_____

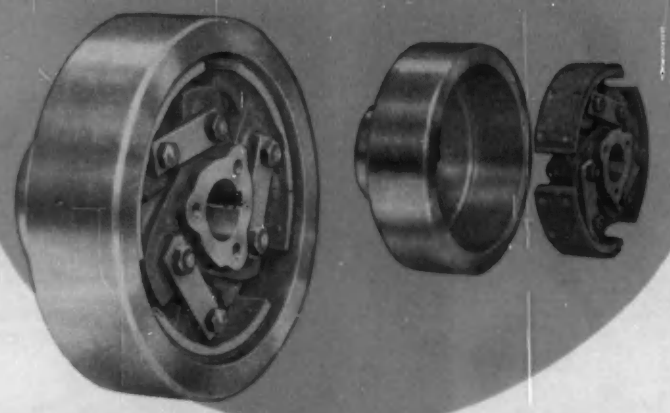
Company_____

Address_____

City_____ Zone_____ State_____

Flexible ACTION IN THE *New* HILLIARD TWIFLEX

AUTOMATIC CENTRIFUGAL CLUTCH COUPLING



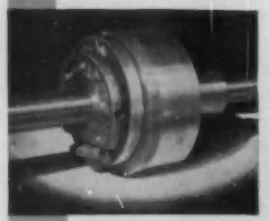
11 NEW IMPORTANT FEATURES..

1. Flexible in all directions.
2. Absorbs Shock.
3. Limits torsional vibration.
4. Has adjustable idle speed.
5. Can be furnished in automatic free-wheeling type.
6. Smooth starting.
7. No slip under normal load at full speed.
8. Protects driver and driven mechanisms against overload shock.
9. Can be furnished in automatic back-stop type.
10. Prevents torsional resonance.
11. Easily assembled even in blind installations.

If you have problems of misalignment — smooth starting — vibration — overload — or assembly in the manufacture or operation of:

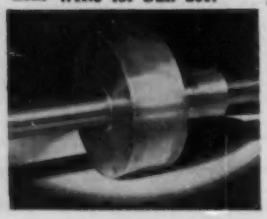
- Compressors
- Blowers
- Diesel Engines
- Excavators
- Refrigeration
- Hammer Mills
- Textile Machinery
- Wire Machines
- Fans
- Gasoline Engines
- Back Stop Brakes
- Mixers
- Conveyors
- Pumps
- Electric Motors
- Generators
- High Speed Pulverizers
- Tube Mills

● Let Our Engineers Consider Your Problem. Twiflex May Be The Answer.



SINGLE REVOLUTION CLUTCH
For automatic, accurate control, electrically or mechanically, of intermittent motion, indexing, cycling, cut-off. Write for Bul. 239

OVER-RUNNING CLUTCH
For automatic engagement and release on two speed drives, dual drives and for ratchet feed or backstop action. Write for Bul. 231.



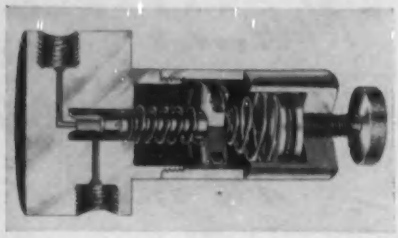
SLIP CLUTCH
For overload protection — constant torque — constant tension on reeling or winding stands. Write for Bul. 300

WRITE TODAY! For Details of TWIFLEX Coupling in Catalog CE-3

THE HILLIARD Corporation

101 W. FOURTH ST. ELMIRA, N.Y.

MANUFACTURING CLUTCHES FOR 50 YEARS



nections are available as desired. Beacon Devices, Inc., 78 Oliver St., N. Tonawanda, N. Y.

For more information— Circle 92, inside back cover

Adaptable Basic Valve Assembly

Four-way ¼ in. valves with a basic assembly that can be used as a spring return hand valve, a spring return foot valve, a self-locking bench valve, a spring return cam valve and a solenoid-actuated valve have built-in speed control. By regulating the size of the exhaust openings in the valve, the speed of a double-acting air cylinder can be controlled in both directions.

Valve base and body is an aluminum casting; seals are neoprene; springs and plungers are all-brass, bronze or stainless steel. Mead Specialties Co., Dept. SV-44 4114 No. Knox Ave., Chicago 41, Ill.

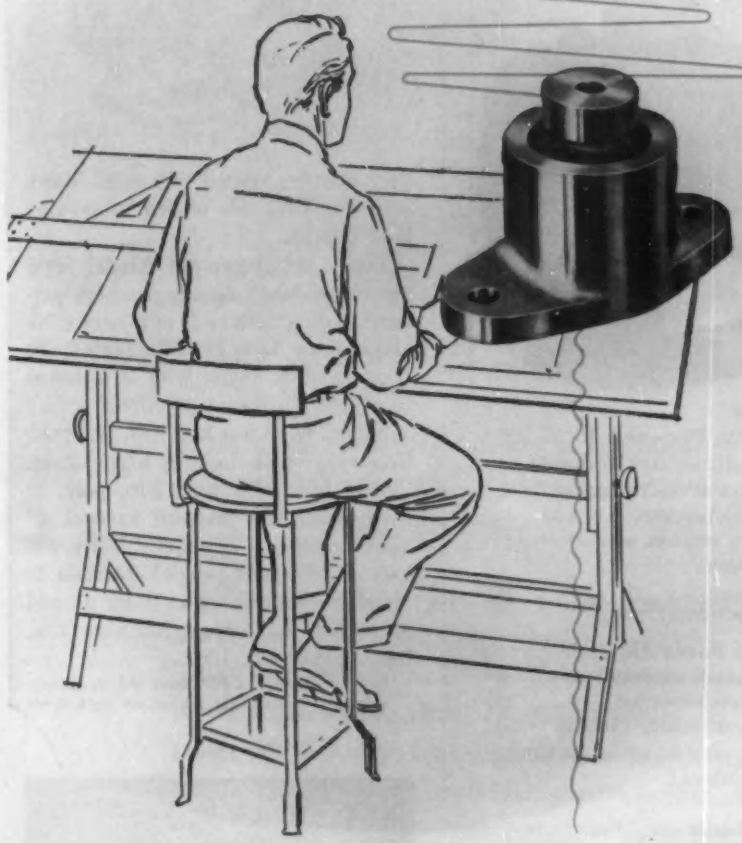
For more information— Circle 93, inside back cover

Three Air Valves With Locking Toggles

Model 6664 is designed for control of bleeder and pilot-operated master valve. Removing plug in lower (center) port makes the valve into a three-way valve. Operated by hand, it will lock in the off-center (angle) position and is released manually to vertical (off) position. Locking posi-

STOP VIBRATION

right at the drawing board!



General Tire's Industrial Products Division can help you control vibration right at the design stage. A new comprehensive design guide on Silentbloc motion control products offers data which enables you to choose a pre-tested unit for your particular product.

Silentbloc rubber-in-metal mounts and bushings soak up vibration and shock and correct misalignment for years with no measurable fatigue.

If your problem is out of the ordinary, General will build a Silentbloc mount to your exact specifications.

For free Silentbloc vibration guide write to The General Tire & Rubber Company, Industrial Products Division, Dept. E-4, Wabash, Indiana.

"From Plans to Products in Plastics and Rubber"

These are General Tire Industrial Products in Industry

Silentbloc vibration and shock mountings • Silentbloc bushings • Silentbloc bearings • Oil & hydraulic seals • Bonded to metal rubber parts • Hydraulic brake parts • Metal stampings • Extruded & molded rubber • Extruded plastic • Polyester glass laminates • Sponge rubber • Glass run channel • Vibrex® fastners.

THE GENERAL TIRE

Industrial Products Division

WABASH INDIANA

high performance SHAKER in CALIDYNE'S new 100 pound force system

BASIC 100 POUND FORCE SHAKER SYSTEM
AUDIO OSCILLATOR
MODEL 68 POWER SUPPLY
MODEL 68 POWER AMPLIFIER
MODEL 102 D.C. FIELD SUPPLY
115V 60 CYCLE SINGLE-PHASE (20 AMPS)
MODEL A88 SHAKER
115 VAC TO SHAKER BLOWERS
7 AMPS D.C. TO SHAKER FIELD
6800 POWER PACK
18"

HIGHER USEFUL OUTPUT, IMPROVED SHAKER DESIGN

Calidyne's new Model A88 Shaker, rated at 100 pounds force output continuous duty over the 40 to 3000 cps frequency range, incorporates several important design changes and refinements. A lightweight, extremely rigid armature of cage-type construction greatly increases the useful portion of total force output. MIL-E-5272A Procedure I requirements, for example, can be met with mass loads up to 7.3 pounds. Also, a new flexure system insures truly *linear* motion of the armature, and trunnion mounting of the Shaker allows forces to be exerted in any direction. And for monitoring amplitude of vibratory motion, a calibrated velocity signal generator has been built into the Shaker.

SINGLE CONSOLE CONTAINS CONTROLS AND POWER PACK

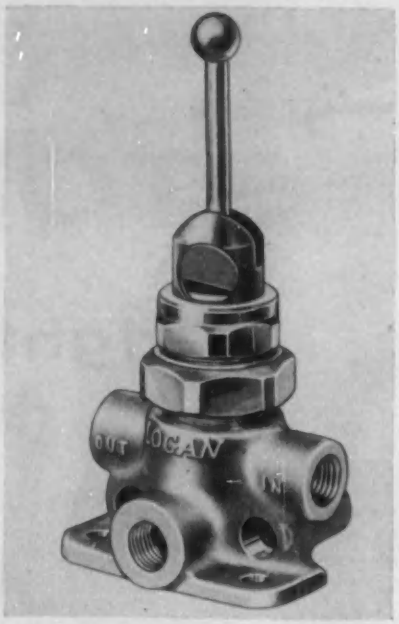
The 6800 Control and Power Pack unit includes the Power Amplifier, Audio Oscillator, and Shaker Field Supply, as well as all controls and indicators, for operation of the complete system. Accessories for monitoring Shaker vibratory levels and performing automatic cycling tests required in many MIL and JAN specifications may be added to the basic system at any time, by rack mounting in the cabinet.

Complete System Specifications and Details Available on Request

THE CALIDYNE COMPANY

120 CROSS STREET, WINCHESTER, MASSACHUSETTS

SALES REPRESENTATIVES:
WALTHAM, MASS. Robert A. Waters, Inc. Waltham 5-6900
NEW HAVEN, CONN. Robert A. Waters, Inc. Fulton 7-6760
NEW YORK CITY AREA G. C. Engel & Associates Rector 3-0091
RIDGEWOOD, NEW JERSEY G. C. Engle & Associates Gilbert 4-0878
PHILADELPHIA, PA. G. C. Engel & Associates Chestnut Hill 8-0892
NORTHERN NEW YORK Technical Services Co.,Boston Capital 7-9797
CLEVELAND, OHIO M. P. Odell Co. Prospect 1-6171
DAYTON, OHIO M. P. Odell Co. Oregon 4441
WASHINGTON, D. C. F. R. Jodan, Inc. Woodley 6-2615
SOUTHEAST W. A. Brown & Assoc. Alexandria, Va. Overlook 3-6100
CHICAGO, ILLINOIS Hugh Marsland & Co. Ambassador 2-1555
INDIANAPOLIS, INDIANA Hugh Marsland & Co. Glendale 3803
MINNEAPOLIS, MINN. Hugh Marsland & Co. Colfax 7949
DALLAS, TEXAS John A. Green Co. Dixon 9918
HOLLYWOOD, CALIFORNIA G. B. Miller Co. Hollywood 9-6305
SAN FRANCISCO, CALIF. G. B. Miller Lytell 3-3438
ALBUQUERQUE, NEW MEXICO G. B. Miller Co. Albuquerque 5-8606
SEATTLE, WASH. G. B. Miller Co. Lander 3320
CANADA Measurement Engineering Ltd. Arnprior, Ont. Phone 400 Toronto, Ont. Mayfair 8860
EXPORT Burke International Corp. 13 East 40th St., N.Y.16, N.Y. Murray Hill 9-0200

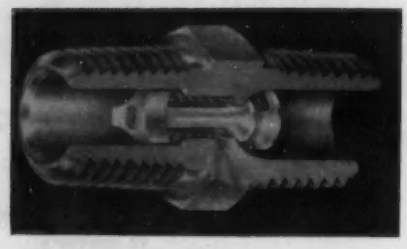


tion may be rotated 360 deg. Valve is designed for side or base mounting. Port is ¼ in.

Dual control two-way Model 6665 has two exhaust openings which permit bleeding both ends of master valve alternately. This provides automatic reversal when toggle lever is returned to normal (vertical) position.

Model 6676 is a four-way, two-position valve with locking toggle lever, side or base mounting, ¼-in. port. It is designed for manual control of double-acting air cylinders. Valve will lock at off-center (angle) position to maintain position of cylinder at end of stroke. Logansport Machine Co., Inc., Logansport, Ind.

For more information— Circle 94, inside back cover



Check Valve for 0 to 10,000 Psi

The floating poppet design is said not to be affected by foreign particles in the fluid and to eliminate "wire drawing" across the seat. The spherical metal seat assures perfect seating and support for the O-ring, which

The high-quality powder metal parts shown here are produced by Dixon Sintaloy Inc., Stamford, Connecticut. A large user of Stokes presses, this progressive firm has done outstanding work in applying powder metallurgy to the economical production of a wide variety of parts for its customers.

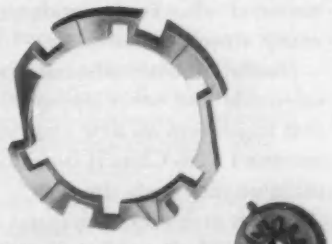
Quantity powder-metal production of this in-the-knob lock part saved one manufacturer over $25,000 per year. In addition, he avoided an outlay for machine tools estimated at $30,000. I.D. tolerances on this leaded brass part are held to ±.0025 inches.

$25,000 saved on this Powder Metal Part

Parts which are difficult to machine because of complex contours—or costly, because of great metal waste—are economically made on fully automatic powder metal presses.

Stokes has been building presses *specifically for the compacting of metal powders for over thirty years.* There's an automatic Stokes press for every powder metal application, from 1½-ton capacity to large presses of 500 tons. Our experience in punch and die design and laboratory facilities for compacting sample parts are available to help you investigate the cost-saving possibilities of powder metallurgy.

Write for the following pieces of literature: "Powder Metallurgy Today," Catalog of Stokes Powder Metal Presses, No. 801, and "How To Save Money on Punches and Dies."



Each of these powder metal parts replaces assemblies: the synchronous motor shading coil at left above, previously assembled from sheet metal stampings, is made of high-conductivity metal powders to close dimensional tolerances at cost savings of 50%; the gear at right is one of nine used in an adding machine with an I.D. tolerance of ±.0005 inches. Formerly a three-part assembly, cost savings on this sintered iron part are 70%.

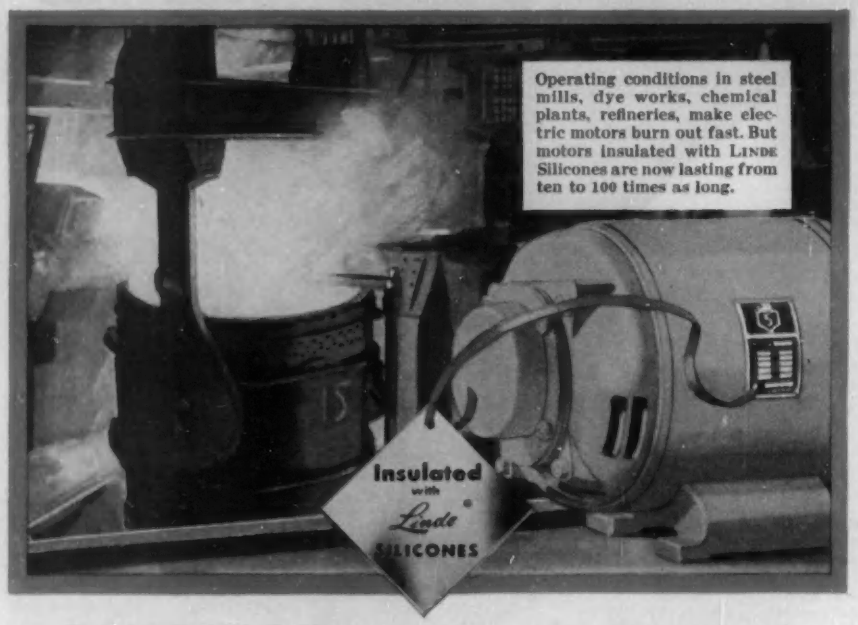
F. J. Stokes Machine Company
Philadelphia 20, Pa.

Offices in principal cities.
Representatives throughout the world

STOKES

LOOK HOW

Linde TRADE-MARK silicones toughen up electric motors


Operating conditions in steel mills, dye works, chemical plants, refineries, make electric motors burn out fast. But motors insulated with LINDE Silicones are now lasting from ten to 100 times as long.
Insulated with Linde SILICONES

LOOK AT the reasons why

Electric motors insulated with LINDE Silicones withstand high heat caused by overloads, frequent starts, and hot locations—prime causes of motor burn-outs. This dependable new insulating material also resists water, ozone, corrosive atmospheres and many strong chemicals.

Insulated with silicones, your electric motors, transformers, solenoids and other apparatus seldom cause down time. Specify this insulation on new equipment. Have your existing equipment rewound with Class H insulation based on LINDE Silicones. Watch maintenance costs drop.

LINDE and other divisions of UNION CARBIDE serve many industries. Their combined experience particularly qualifies LINDE to supply the correct silicone for electrical insulation, water repellents, protective coatings, release agents, and other uses. Let us show how these versatile new chemicals can improve your products or processes, increase your profits. Write Dept. P-5.

LOOK TO Linde for silicones

Linde AIR PRODUCTS COMPANY | A DIVISION OF UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street, New York 17, N. Y.

In Canada: Dominion Oxygen Company, Division of Union Carbide Canada Limited

The term "LINDE" is a registered trade-mark of Union Carbide and Carbon Corporation.

serves as a sealing member and absorbs closing shock.

Suitable for most high pressure hydraulic or pneumatic application, the valve is of one-piece body construction and is available in several body and O-ring materials combinations. James-Pond-Clark, 2181 E. Foothill Blvd., Pasadena 8, Calif.

For more information—Circle 95, inside back cover

On-and-Off Valve of 8 to 10 Gpm Capacity

A lightweight, positive-locking, push-pull type valve, manually operated, that can be readily adapted to remote control is rated at 1000 psi. For mounting in any position, it is equipped with dust and moisture seals. Capacities range from 8 to 10 gpm. Overall dimensions are 8½ x 3¼ in. Weight is 5¼ lb. Wisconsin Hydraulics, Inc., 3165 N. 30 St., Milwaukee 16, Wis.

For more information—Circle 96, inside back cover

Toggle Valve for Pressures to 1000 Psi

A series of bar stock toggle valves, ranging in size from ⅛ to ½ in., have

hardened steel cams to provide a valve seat closing action tight enough for high vacuum service. Leakage during opening and closing is said not to exceed 0.01 micron liter per cycle.

Bodies of the toggle valves are machined from bar stock, with valve seats of semi-hard, plastic, corrosion-resistant material. Brass valves have O-ring seals, and stainless steel types are available with either O-rings or Teflon chevron packing. Hoke, Inc., 197 S. Dean St., Englewood, N. J.

For more information—
Circle 97, inside back cover

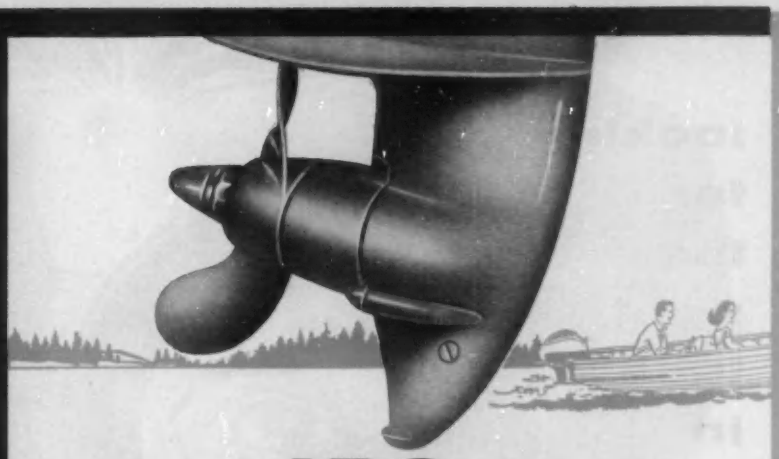
Stainless Steel Solenoid Valves

Piston, pilot valve and spring are the only moving parts operating in this valve's packless operating chamber. Unbreakable stainless steel piston rings are said to give free floating piston action. Waterproof molded coils for temperatures to 250 F are glass insulated and silicone impregnated. Coils are interchangeable between sizes and are also the same as those used on this maker's standard bronze valves. Valves are made in ¼, ⅜ and 1 in. sizes. J. D. Gould Co., 730 E. Washington St., Indianapolis 2, Ind.

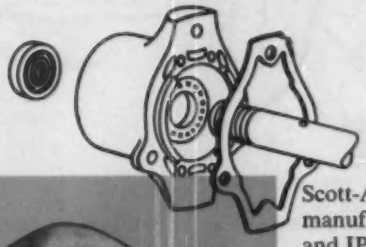
For more information—
Circle 98, inside back cover

Needle Valve Has One-Piece Body

A "T"-shaped forging permits the manufacturer to combine body and stem guide in this valve. The result is a valve body without welds of any kind, one that is described as being unable to leak or come apart, even with a proof test of 25,000 psi pres-



How IPC helps Scott-Atwater keep the oil in . . . water out



The synthetic rubber sealing member, press fit into this brass rolled case, has a 70 durometer, high resistance to oil and abrasion, and withstands temperatures down to —20°F.

Scott-Atwater, world famous manufacturer of outboard motors, and IPC have worked together to solve an underwater problem. An IPC oil seal designed to keep oil in . . . water out, is used on the lower propeller shaft on 5 horsepower models.

Substantial pressures are exerted on this sealing unit and IPC's oil seal has eliminated "blow-outs" which sometime occurred with old style packings.

Whatever your packings problem, pneumatic or hydraulic, IPC engineers will help you select the best material . . . the most effective design. Standard and special type packings are available in both leather and synthetic rubber.

IPC PACKINGS

IPC serves industry with cup, flange, U and Vee packings, oil seals and custom packings.

Cup Flange U Vee Oil Seals

INTERNATIONAL PACKINGS CORPORATION
A subsidiary of Graton & Knight Company
Bristol, New Hampshire

P3

looking for the right tube in

WELDED STAINLESS?

Check Standard's Complete Range of tube and pipe sizes!

Whether it's for a pressure, mechanical, sanitary or ornamental use – Standard offers you a convenient "one source" answer to your welded Stainless Steel Tubing need.

TUBE SIZES: ¼" to 4" OD .025 to .148

PIPE SIZES: ⅛" to 2" IPS Schedule 40

TYPES: 430, 302, 304, 309, 316, 321, 347; and others including low-carbon grades.

SHAPES: Squares, Rectangles and Special Shapes

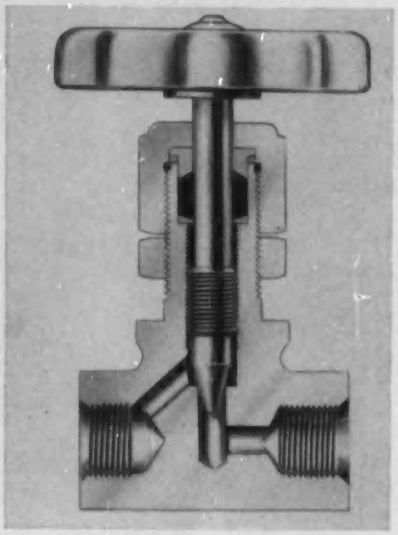
PIPE SIZES: ⅛" to 4" IPS Schedules 5 & 10

Send for Stainless Folder! Our engineers will gladly assist you in your selection of the tube best suited to your needs! Write today!

Specify Standard for

- WELDED STAINLESS TUBING AND PIPE
- WELDED CARBON STEEL MECHANICAL TUBING
- BOILER AND HEAT EXCHANGER TUBING
- EXCLUSIVE "RIGIDIZED" PATTERNS

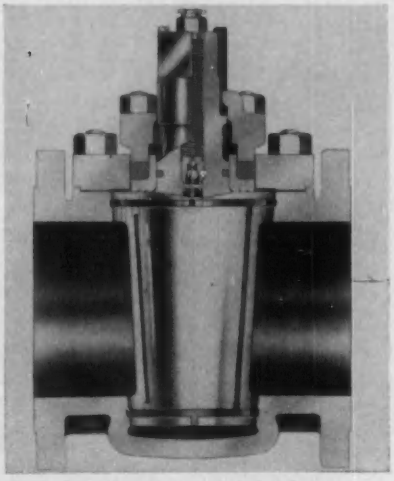
THE STANDARD TUBE CO.
Detroit 28, Michigan
Welded Tubing
Fabricated Parts
STANDARDIZE with STANDARD



sure. It is designed for working pressures up to 10,000 psi, to 200 F, in water, gas, oil and vacuum service.

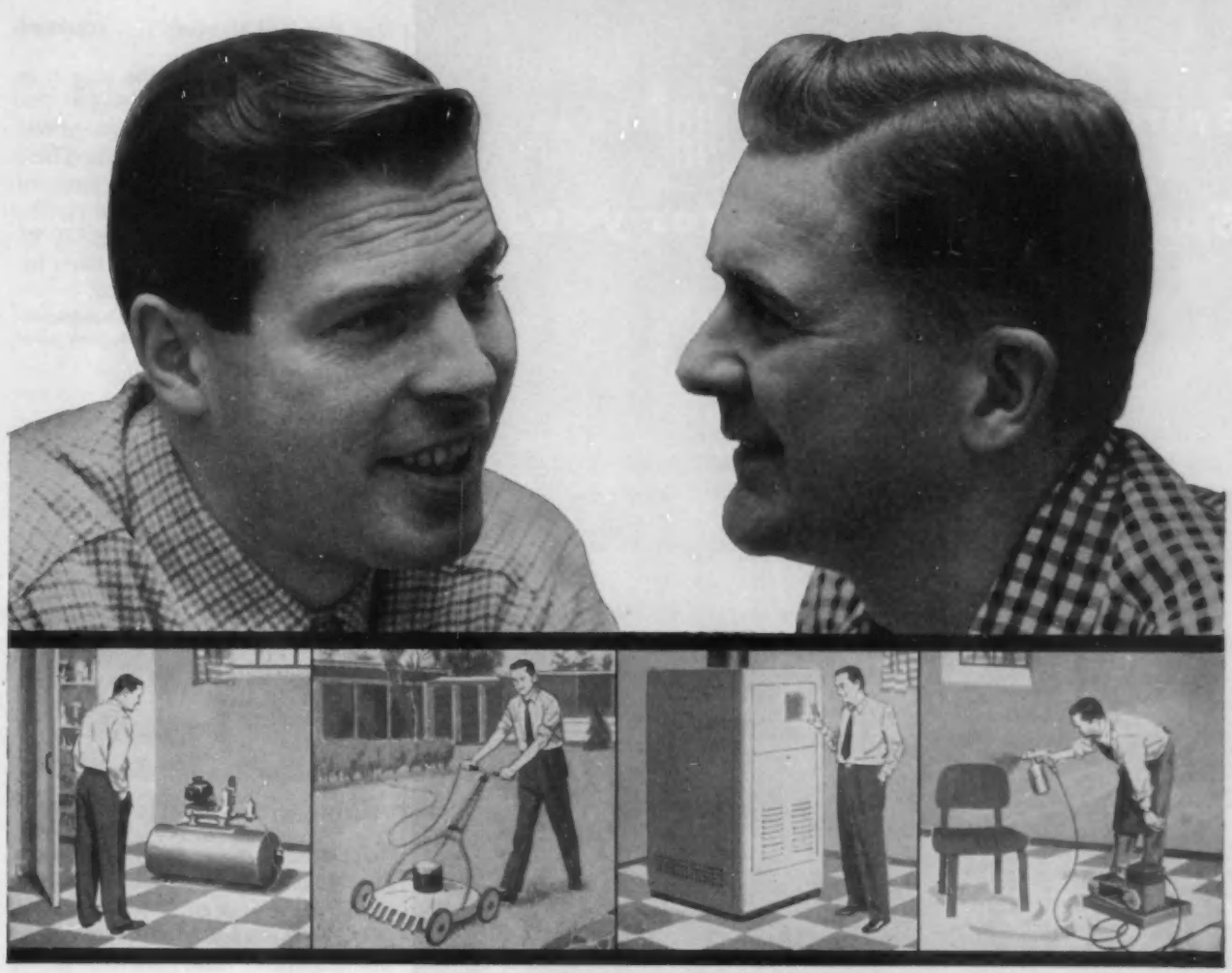
For packing, there is a choice of graphited asbestos or Teflon. Made with female pipe thread connections, sizes ⅛, ¼, ⅜, and ½ in. are available. Republic Mfg. Co., 15655 Brookpark Road, Cleveland 11, Ohio.

For more information— Circle 99, inside back cover

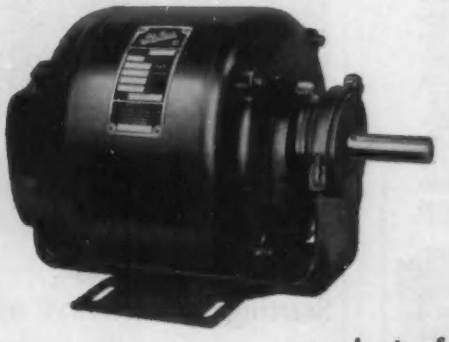


Lubricated Plug Valve

This valve is said to provide multiple sealing, which includes lubricant, O-ring, gland liner and packing seals. Four vertical lubrication grooves in the plug assure uniform and adequate distribution of a sealing lubricant around the port areas. Two grooves (180 deg apart) do not cross body ports in operation; two grooves (180 deg apart) do cross body ports in operation but are connected with lubri-



Satisfied Customers sell new customers...



Look at this man. He's telling a neighbor why he's so pleased with his motor driven appliances. He—a satisfied customer—is just about the best salesman a product can have! One *big* reason for his satisfaction—even though he may not know it—is the Packard Electric motors that power his appliances.

Packard fractional horsepower electric motors have been making satisfied customers for 38 years—because a Packard motor does its job longer, quieter, with less maintenance cost. The appliance maker who standardizes on Packard Electric motors gives his product that extra touch of dependability that builds sales.

product of GM GENERAL MOTORS *General Motors*

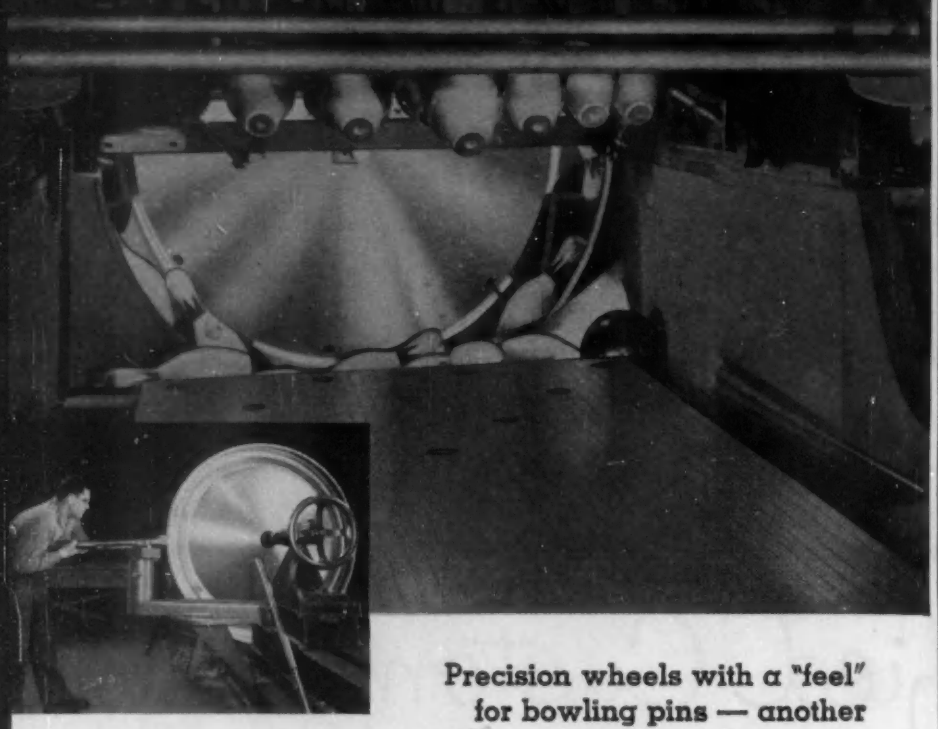
Packard

REG. U.S. PAT. OFF.

Packard Electric Division,
General Motors,
Warren, Ohio

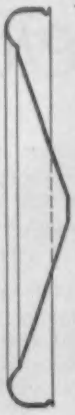
Spincraft did it for AMF . . .

Spincraft can do it for you!



NINE DIFFERENT OPERATIONS—
Spinning and forming tolerances to .031"

On each 5-ft. wheel, Spincraft assumed 100% fabricating responsibility: deep draw, spin, punch, blank, stamp and form, pantograph (chamfer), surface finish, drill, rivet, carton and ship. Operator (above) is spinning the ⅛-in. thick sheet of tough 52S aluminum alloy. Cross-section of basic wheel (right) shows unusual contour requirements. Raised segments are ⅛-in. cold rolled steel.



Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

Precision wheels with a "feel" for bowling pins — another example of Spincraft's fabricating skill

By setting pins faster, American Machine and Foundry's automatic pin spotter gives more bowlers more opportunities for better scores! Spincraft is proud to have successfully fabricated a key component of the AMF pin spotter. It's the large-diameter pin elevator wheel — our solution to a difficult production problem for this well-known manufacturer.

This is *one more* example of Spincraft's versatility, capacity and skill. We offer complete facilities for contract manufacture of metal parts or complete units. No jobs are too big — or too small. One piece or millions are taken in stride.

Engage the facilities of the world's largest metal spinning plant — the only such plant also equipped for deep drawing, stamping and complete fabrication. You'll get results and savings that far exceed your expectations!

SERVING INDUSTRY SINCE 1919 . . .

World's largest plant fully equipped for all types of metal spinning • deep drawing • stamping • fabricating

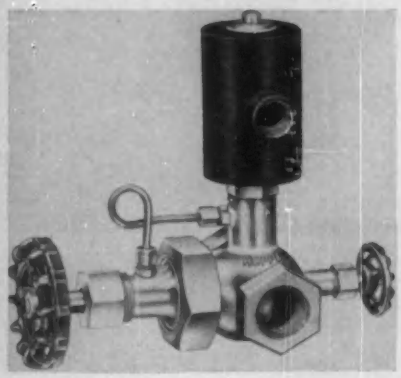
Spincraft
SKILL WILL DO IT
INCORPORATED

4124 WEST STATE STREET • MILWAUKEE 8, WISCONSIN

cant supply only when the plug is in fully opened or closed position.

The gland liner is bronze, with low friction bearing characteristics. These plug valves are available in steel, in the 150 and 300 lb pressure classes, and in semi-steel, 150 through 800 lb. Sizes range from ½ to 12 in. Ohio Injector Co., Wadsworth, Ohio.

For more information—
Circle 100, inside back cover

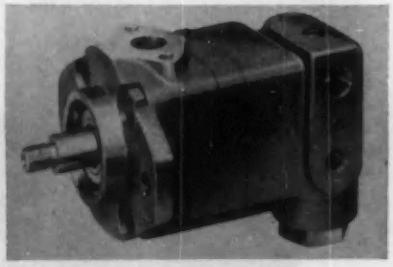


Automatic Throttle Valve

This valve serves three purposes: a throttle valve, solenoid and check. The check valve operates regardless of whether the solenoid is energized or de-energized. Valve shown is of bronze, designed for pressure of 300 psi with renewable disc, 600 psi with renewable disc and nickel seat.

Valves can be furnished in sizes from ¾ to 3 in., inclusive. Hoppe Engineering Co., Inc., Greensboro, Ind.

For more information—
Circle 101, inside back cover



Pump For Hydraulic Starting Systems

An oil-hydraulic pump designed for hydraulically powered engine starting systems is designed for use in an accumulator system in gasoline or diesel engines for stationary or mobile units.

The pump includes an integral un-

loading valve. It is suitable for installations using working pressures up to 2500 psi and speeds up to 3600 rpm. The new unit delivers 1.5 gpm at 2000 rpm and 2000 psi. It can be driven directly or with a gear drive.

When the accumulator pressure reaches the 2500 psi setting, the unloading valve allows pump delivery to by-pass the accumulator and return directly to the reservoir. When pressure drops to between 2100 and 2150 psi, flow is once again directed to the accumulator.

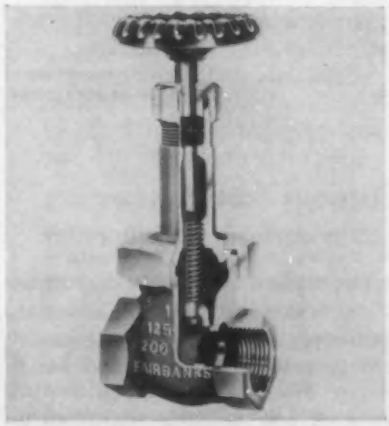
The new pump is available with standard flange-type mountings only. Major overall dimensions are 7$\frac{3}{32}$ x 5$\frac{1}{8}$ x 4$\frac{5}{32}$ in. Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.

For more information—
Circle 102, inside back cover

Hydraulic Reservoirs

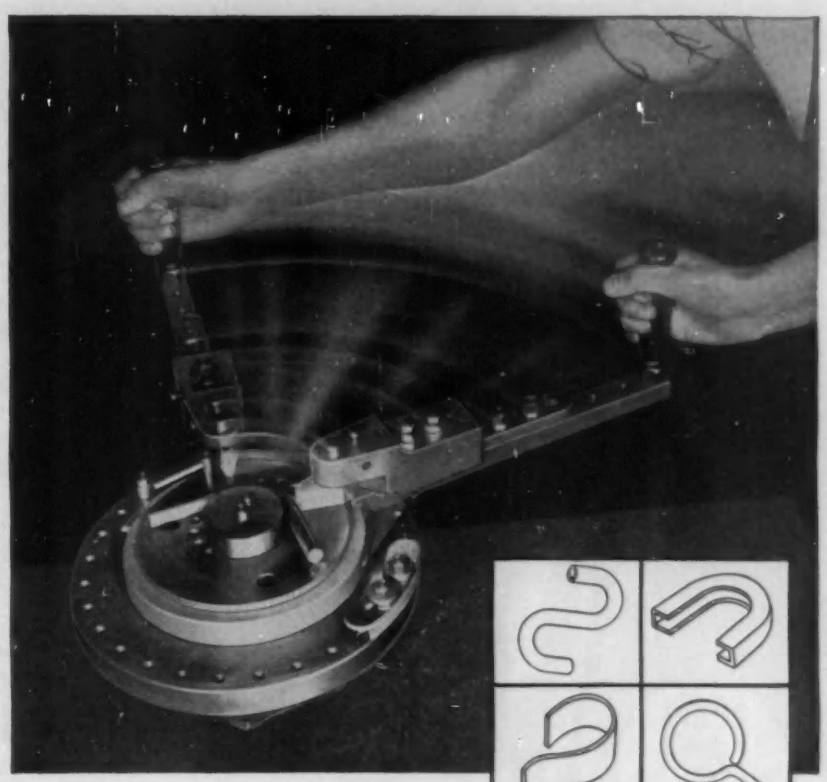
These tanks are designed to form the nucleus of complete power units. They have a large mounting space on top, and also all the necessary mounted accessories (fittings, pipes, breather, filler cap, gaskets). Of all-welded construction, the tanks are available from stock, as are all the necessary parts. The Rosaen Co., 24100 Harper Ave., St. Clair Shores, Mich.

For more information—
Circle 103, inside back cover



Union Bonnet, Rising Stem Gate Valves

Gate valves in the 125 lb and 150 lb steam working pressure classes which were recently introduced have a radial seat which is machined ball and socket joint. The two-piece construc-



Bend a Variety of Materials

Accurately, Easily, Quickly with a *DI-ACRO* BENDER*

Simple and complex bends can be formed and duplicated in many ductile materials with a versatile Di-Acro Bender. Bending capacity of the five hand operated models ranges from 1/16" wire to 1" round mild steel bar. Many accessories are available for bending various materials and shapes. The Di-Acro Bender can be delivered completely tooled for most forming requirements in solid materials and tubing.

DI-ACRO HYDRA-POWER BENDER

A universal hydraulically operated bending machine that is equally as flexible as hand operated machine. Di-Acro Hydra-Power Benders are especially designed for those long runs and heavy bending operations which are impractical for manually operated equipment.

*Pronounced Die-ack-ro.

WANT MORE INFORMATION? *Send for New 32-Page Catalog*

Gives complete details on hand and power operated DI-Acro Benders, Brakes, Notchers, Punch Presses, Rod Parters, Rollers, Shears, Press Brakes and Spring Winders. Send for your copy today — there's no obligation.

Creators of "DIE-LESS DUPLICATING"

di-acro PRECISION METALWORKING MACHINES

O'NEIL-IRWIN MANUFACTURING CO.
333 8th Avenue • Lake City, Minn.

Standard Quality sets Quality Standards

The day-in, day-out excellence, the quality which is standard in every Curtis Universal Joint, has made the Curtis Joint the quality standard of the industry.

Each Curtis Universal Joint component is made from specially selected steel, individually heat-treated for a specific purpose. This accounts for the long life and dependable performance of Curtis Universal Joints.

CURTIS UNIVERSAL JOINTS

- 14 sizes always in stock
- Fewer parts, simpler construction
- Complete equipment for government tests

Our catalog torque and load ratings are substantiated by constant tests. You can depend on them.

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK CURTIS

UNIVERSAL JOINT CO., INC.

11 BIRNIE AVENUE, SPRINGFIELD, MASS.

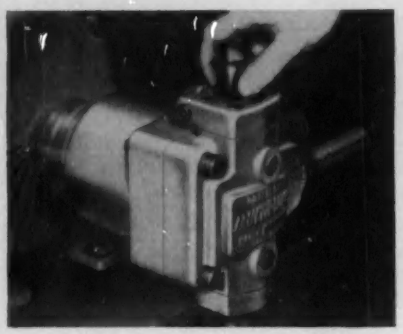
As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

tion is asserted to eliminate sliding, scraping and scoring of the mating body and bonnet surfaces during assembly and disassembly. It provides even contact pressure over the mating surfaces. The heavy union nut will not deform under pressure and it protects the body and the bonnet from distortion and wrench abuse. The new valves may be repacked under pressure when open and the top seat is located above the stem threads. Fairbanks Co., 393 Lafayette St., New York 3, N. Y.

For more information—Circle 104, inside back cover

Variable Volume Vane Pump



This pump will deliver variable volume at constant speed, or constant volume at variable speed. Its fingertip volume control works independent of compensator. The pump is said to hold volume within ±5 per cent over desired pressure, and designed speed ranges.

This unit can be used: 1) where constant volume pumps are now used and a need exists for varying the volume; 2) where piston or gear pumps are used for pressures up to 1000 psi continuously; 3) where systems that call for high and low volume are served by double pumps; 4) where volume must be held constant while changing pump speed. The new pump is available in three sizes: Series DFB-5 gpm at 1200 rpm, 7½ gpm at 1800 rpm, weight—20 lbs, maximum operating pressure—1000 psi (continous); Series DFC-15 gpm at 1200 rpm, 22½ gpm at 1800 rpm, weight—38 lb, maximum operating pressure—1000 psi (continuous); Series DFD-25, gpm at 1200 rpm, 37½ gpm at 1800 rpm, weight—53 lb, maximum operating pressure—1000 psi (continuous). Denison Engineering Co., Columbus, Ohio.

For more information—Circle 105, inside back cover

ENGINEERING MATERIALS

Unwoven Fibers In Resin Binders

Any cardable fiber, such as wool, rayon, cotton, dynel, nylon and dacron, alone or in combination, can be used as the basic raw material of these non-woven materials. Fibers of different diameter, length and specific gravity can be combined and evenly distributed throughout the binder mass, permitting a range of fiber combinations for specific purposes. Resin binder content, applied automatically and evenly during the carding operation, can be varied from 5 to 75 per cent.

Initial production will be in thicknesses ranging from ⅛ to 2 in. (greater thicknesses are possible). Widths being produced are from 50 to 80 in., and multiples of these widths. The density of the material, controlled by the ratio of resin to fibers and determined by the end uses, may run from a springy fluffiness to high densities. Felters Co., Boston, Mass.

For more information—Circle 106, inside back cover

Coatings Based on Fluorocarbon Polymers

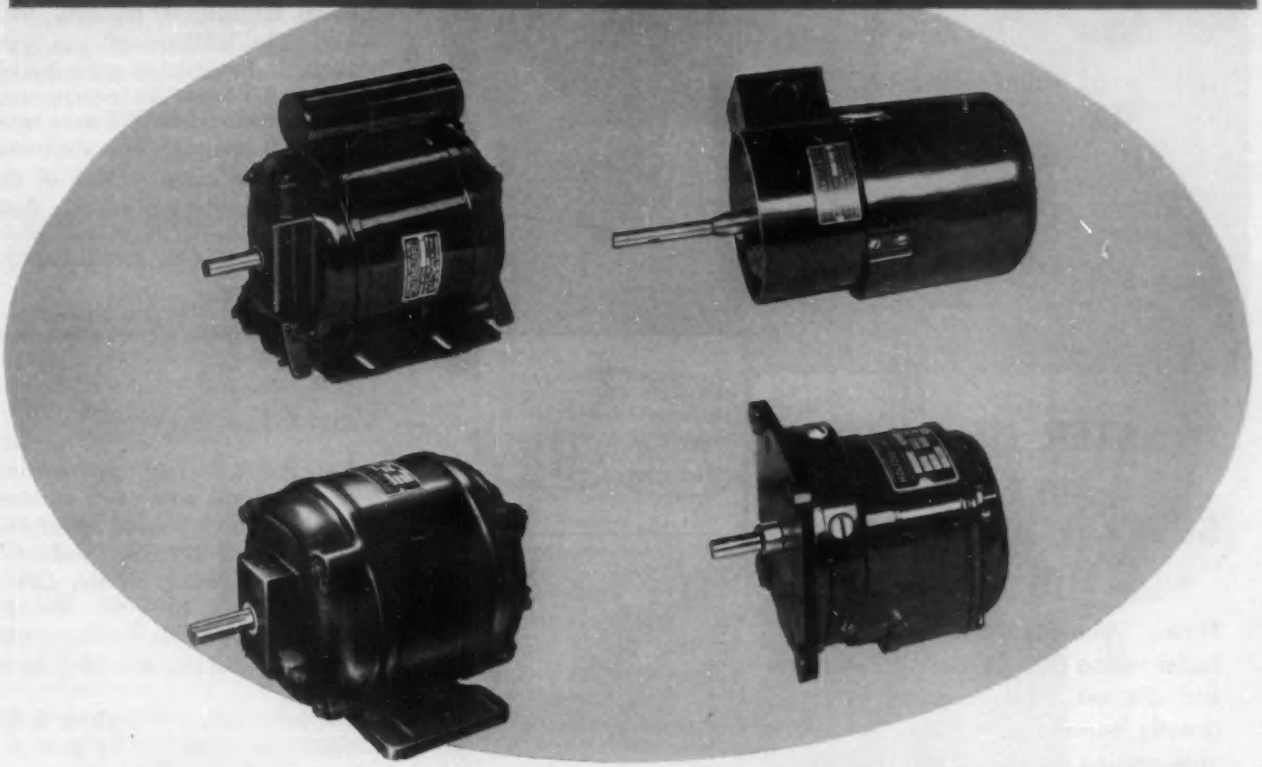
The application of these dispersions is said to result in a tough, adherent, continuous coating with all the important properties of the original Kel F plastic. They consist of finely divided particles, 1-20 microns, suspended in volatile organic liquids, similar to those employed in normal paint and lacquer systems. Non-running, smooth, wet films result which fuse to a film thickness of approximately 2 to 2.5 mils.

Two major types of dispersions are available commercially: NW-25-TR, a

HOLTZER-CABOT

Fractional Horsepower Motors

1/200 to 1 H. P. – 3" to 7" frame diameters – single phase, polyphase, direct current



Holtzer-Cabot fractional horsepower motors are available in an extensive range of electrical types, frame diameters, lengths, mechanical and electrical variations. This wide range permits the selection of the ideal motor for your product. Or, if needed, our highly skilled personnel can develop, promptly and efficiently, special custom-built motors for your specific applications.

The following basic motor designs are available for 60-cycle operation. Most of the a-c designs have d-c companions. Electrical variations include: voltage, frequency, single or polyphase operation. Partial motors, for direct insertion into your product, are also available.

ELECTRICAL TYPES

- SPLIT PHASE
- CAPACITOR
- SYNCHRONOUS
- REPULSION INDUCTION
- SERIES AC OR UNIVERSAL
- DIRECT CURRENT
- POLYPHASE
- MULTI-SPEED
- RAPID REVERSING
- GENERATORS

These types can be combined to provide motor-generator sets, inverters, dynamotors, frequency changers, and countless varieties of electrical apparatus (up to 7" in diameter) which are not normally classed as motors or generators.

Mail coupon today for complete information

TYPICAL MECHANICAL FEATURES

Ball or sleeve bearings
Special mountings: resilient, laminated steel spring or rubber, flange, face, vertical
Open or totally enclosed
Special shafts — unlimited variations; double shafts to 43" long
Special lubrication for any mounting position or operating condition
Special shapes, e.g. "pancake" type with short axial length
Partial motors

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN ☐ Please send me complete design information on Holtzer-Cabot fractional horsepower motors.

☐ Please have representative call..... (date)

Name.....

Title.....

Company.....

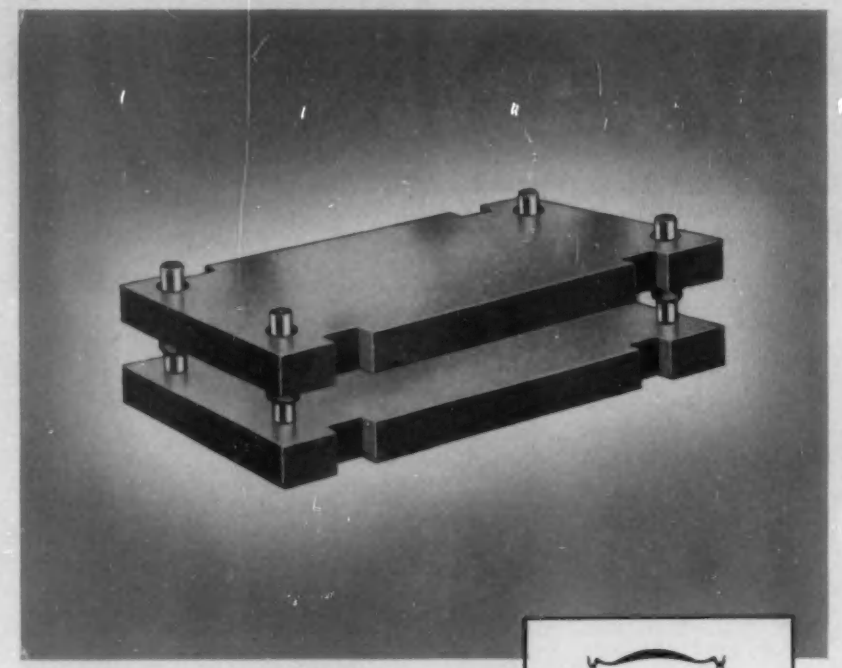
Street.....

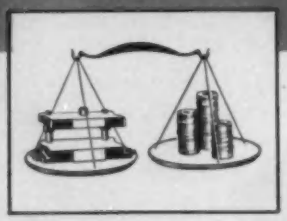
City.....*Zone*.. .*State*. . . .

NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

125 Amory St., Boston 19, Mass.
Sales Service Representatives in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems





FASTER DELIVERY
on Both
SPECIAL and STOCK
DIE SETS

Now . . . you can get into production faster with a Detroit special or standard die set. *First,* because of our greatly expanded facilities, we are now making delivery in less time. For instance, a standard die set will be shipped within 24 hours; specials in remarkably short time. *Second,* because every *full-value* Detroit die set is built up to our high standard and not down to a price and is factory-tested to specifications. Such precision gives you faster mounting without the delay and cost of reworking the set in your shop. Why not talk things over with our nearby representative? Write today.

"full value"

means that in a special or standard Detroit die set you get what you pay for . . . the exact, specified thickness of both die holder and punch holder, true parallelism of surfaces, precision fit of pins and bushings — all assured by precision manufacture, factory assembly and factory inspection.

•

PRECISION-BUILT ACCESSORIES

In stock for immediate delivery is an extensive range of die-makers' accessories, including the new self-oiling guide pin bushings.

Detroit
DIE SET
CORPORATION

2895 W. GRAND BOULEVARD • DETROIT 2, MICHIGAN
Offices in Principal Industrial Centers

low-viscosity dispersion supplied at normal spray viscosity (Zalm G-1 viscosity of 32-34 sec), and N-2, a high viscosity dispersion for spread, flow and dip coatings. Low molecular weight waxes are included in the general-purpose spray formulation which can be thinned, if required, with xylene. The addition of wax contributes to the cohesion and adhesion of the air-dried particles to supporting surfaces. It also promotes a more rapid fusion of the particles into a continuous film. The major portion of the wax votalizes during baking. Both types are supplied as 40 per cent solids. M. W. Kellogg Co., 225 Broadway, New York, N. Y.

For more information—
Circle 107, inside back cover

Vinyl Glass Sleeving

A vinyl glass sleeving that combines stabilized organic resins with those of the silicone group is made for a minimum individual dielectric breakdown of 8000 v, meeting NEMA Grade B-A-1, which calls for 5000 v. This dielectric strength of the sleeving is said to be still unchanged after 2000 hr at 130 C.

The new sleeving is available in all standard sizes from No. 24 to $\frac{3}{8}$ in., inclusive, with up to 2 in. dia on special order. Ten colors are offered, on spools, in coils, in 36 in. lengths or cut to specifications. Bentley, Harris Mfg. Co., Conshohocken, Pa.

For more information—
Circle 108, inside back cover

Rigid PVC Pipe

This plastic pipe is being made available in all standard pipe sizes from $\frac{1}{4}$ to 2 in. The pipe can be threaded and is used with rigid PVC fittings sold by the same company. Easton Plastic Products Co., 900 Line St., Easton, Pa.

For more information—
Circle 109, inside back cover

Vinyl Mastic Coating

This coating can be applied at a thickness of 10 mils in one double-pass spray coat, with conventional industrial spray equipment. The dense, highly impermeable protective film

does not flow away from edges and sharp corners and therefore provides extra protection for these areas which are particularly susceptible to corrosive attack. The manufacturer states that the new coating has a non-volatile content in excess of 55 per cent, which is nearly twice the non-volatile content of most vinyl maintenance coatings. Amercoat Corp., 4809 Firestone Blvd., South Gate, Calif.

For more information—
Circle 110, inside back cover

Protective Coating for Thermal Insulation

This coating is compounded from neoprene, silicone rubbers and other resins. It has high mechanical strength and provides a moisture resistant cover which protects insulation from damage by abrasion or puncture.

This covering is manufactured in two grades. No. 1 is a medium viscosity material designed for use with 85 per cent magnesia, calcium silicate, felt, rock wool and asbestos. It can be applied by spraying, brushing or sponge. No. 2 is a high viscosity material designed for use with low temperature insulation such as cork, foamed plastics, glass fiber and cellular glass. It is applied by brush or trowel and is a vapor barrier. West Chester Chemical Co., Box 39, W. Chester, Pa.

For more information—
Circle 111, inside back cover

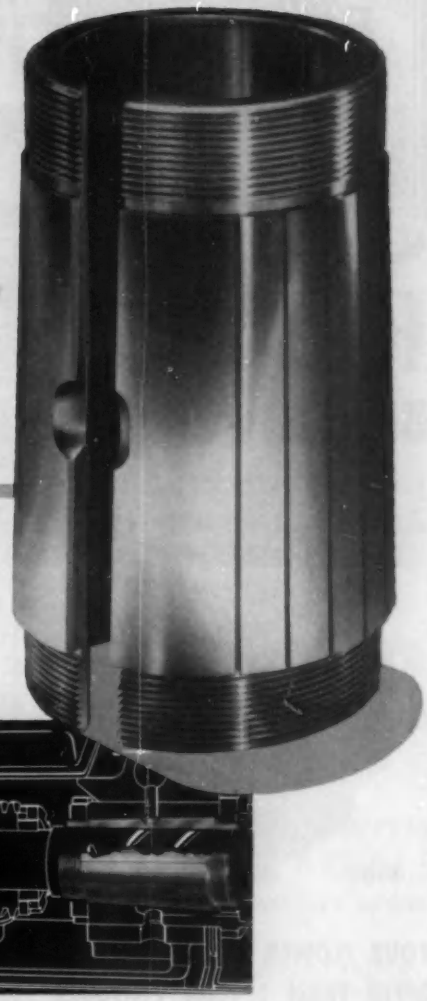
Fluxless Soldering Of Aluminum

This ultrasonic soldering iron makes possible the joining of aluminum, magnesium and their alloys without flux or where corrosive fluxes must be avoided. It is particularly useful for soldering metals that form refractory oxides, without tinning or special surface pretreatment. It can be used also for filling voids in aluminum or magnesium castings. Its light weight and portability enables an operator to solder such items as pipes, gutters and wave guides, which are not normally available for bench assembly.

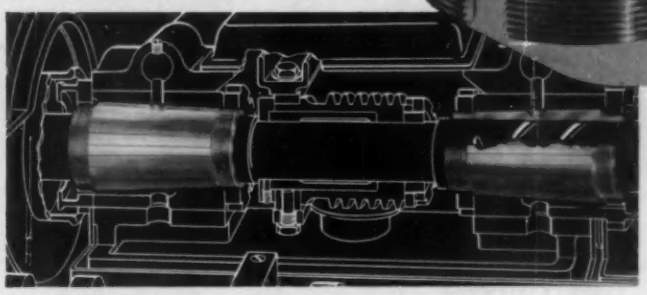
Two models are available: U 610 is gas fired, and U 611 is electrically heated. Both models utilize a soldering tip attached to a transducer powered by an ultrasonic generator requir-

Assembly Costs Go Down

...WHEN BUNTING BEARINGS ARE SPECIFIED



In assembling units equipped with Bunting Bronze Bearings there is no bearing to be pressed against a shaft shoulder no lock nut nor washer to hold the bearing and no outside end cover or enclosure.



Preparation of parts for assembly of a unit equipped with bearings and the actual assembling operations often add serious costs which can be eliminated by the use of Bunting Cast Bronze Bearings. The assembly of a unit equipped with Bunting Bearings is the simplest, easiest and most economical bearing assembly possible.

It will pay you to investigate the cost reductions made possible by the use of Bunting Cast Bronze bearings in your product. There is a Bunting engineer near you for consultation, or write our Product Engineering Department at Toledo.

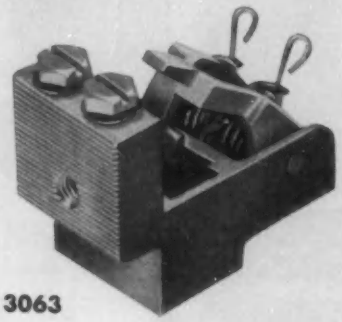
Bunting®

BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS
THE BUNTING BRASS AND BRONZE COMPANY, TOLEDO 1, OHIO
BRANCHES IN PRINCIPAL CITIES • DISTRIBUTORS EVERYWHERE

Precision Engineered for PEAK PERFORMANCE

FLOWER
BRUSH HOLDERS

- MORE THAN 1,000 TYPES AVAILABLE
- INDIVIDUALLY DESIGNED FOR SPECIAL APPLICATIONS



3063

YOUR FLOWER BRUSH HOLDERS OFFER THESE SPECIAL FEATURES

EXACT: engineered to your specifications for a rigidly constructed, long wearing BRUSH HOLDER.

ACCURATE: engineered to your needs for the accurate dimensions of the box interiors to persist for long periods of time.

RIGHT: engineered from design to manufacture for the special type of BRUSH HOLDER your specifications require.

CHECK FLOWER PRECISION ENGINEERED BRUSH HOLDERS NOW!
WRITE FOR CATALOG 4-P

FLOWER PHILADELPHIA

D. B. FLOWER MFG. CO.

1217 Spring Garden Street, Phila. 23, Penna.

ing an output of only 35 w. The gas model is mounted directly on a torch with a small tank which serves the dual purpose of a handle and container for propane, while the electric model has a 65-w heating element inside the tip. The transducer assembly weighs less than 1½ lb, and the generator 15 lb. Vibro-Ceramics Corp., Metuchen, N. J.

For more information—
Circle 112, inside back cover

Protective Paint

When dry, this paint forms a continuous, oil-resistant neoprene rubber film. The painted surfaces are actually coated with a thin sheet of rubber which adheres to the coated surfaces. It is available in black, aluminum and colors. Adhesive Products Corp., 1660 Boone Avenue, New York 60, N. Y.

For more information—
Circle 113, inside back cover

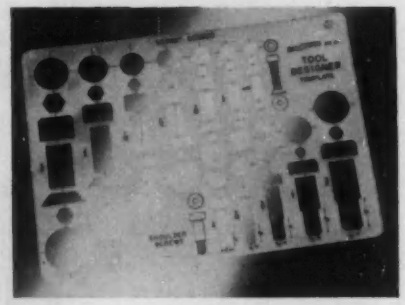
ENGINEERING EQUIPMENT

Measuring Magnifier

This comparator employs a real glass reticle. The reticle pattern is etched in the glass, and the etching is filled with pigment to make reading easier. It is asserted that the glass will not bend or warp, eliminating the possibility of damage or error in measuring.

The reticle has a thickness comparison scale, a series of parallel lines 0.002 to 0.007 in. apart. The linear scale is given both in millimeters and decimal inches. The millimeter scale is 10 mm long, subdivided into units of 2 mm. The decimal inch scale is 0.5 in. long, subdivided into units of 0.005 in. Hole diameters are given in fractions from $\frac{1}{64}$ to $\frac{1}{16}$ in., in decimals from 0.005 to 0.050 in. The complete unit measures 2 in. long and 1 in. dia. Edmund Scientific Corporation, Barrington 3, New Jersey.

For more information—
Circle 114, inside back cover



Drafting Template For Screws

This template covers seven sizes of socket screws, from No. 10 to $\frac{3}{8}$ in. thread diameter, and five sizes of shoulder screws from $\frac{1}{4}$ to $\frac{3}{8}$ in. shank diameter. All sizes have cut-outs for respective head diameter and wrench size, and all sizes have cut-outs for front elevation and top view.

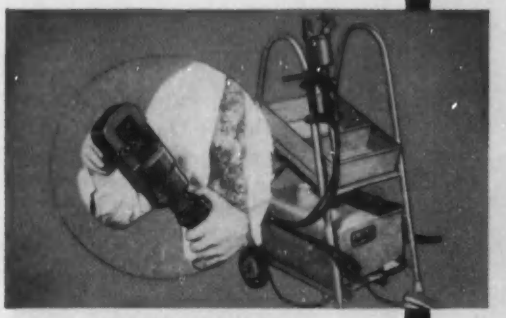
Made of 0.030 in. matte finish mathematical quality plastic, actual size of the template is 8½ x 6 in. Rapidesign, Inc., Box 592 Glendale, Calif.

For more information—
Circle 115, inside back cover

Vacuum Tube Voltmeter

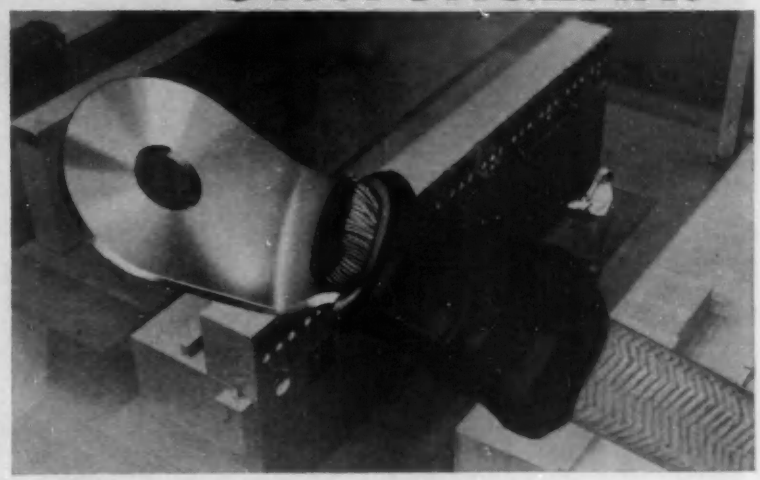
This voltmeter is designed for the measurement of a-c voltages from 0.001 to 300 v, full scale, in the frequency ranges from 20 cps to 2 mc. The input impedance of 10 megohms and 25 mmf minimizes errors due to loading of the circuit under test. Separate terminals are brought out from the input and output of the amplifier section of the instrument, permitting its use as a separate amplifier with

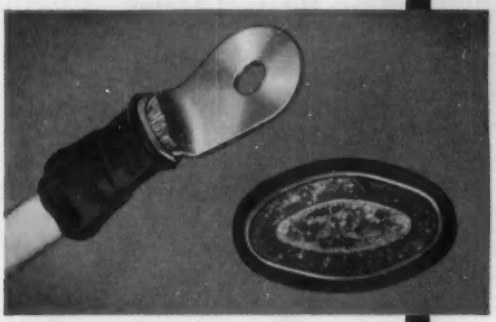
AMP FIRST IN SWITCHGEAR!



NEW DYNA-CRIMP TOOL

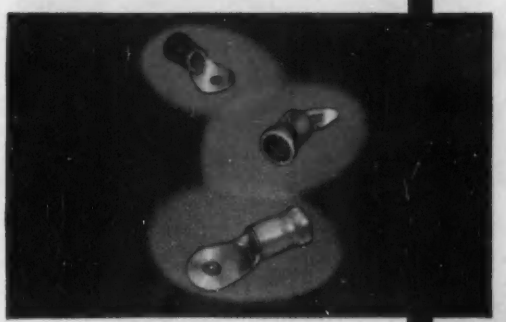
New, powerful, DYNA-CRIMP tool features fast positive crimping action and easily-opened swivel head. Crimping heads can be changed easily. A-MP DYNA-CRIMP tool gives maximum portability with remote control operation. Interchangeable dies are available for use with A-MP's complete line of Aluminum and Flag terminals. Shown above with moveable cart to transport power unit providing maximum flexibility for Bench-Production line use.





BONDING FEATURE MOST IMPORTANT

Bonded insulation is the most important factor *in producing a successful insulated terminal.* The positive and complete bond of the insulation to the terminal sleeve insures uniform insulation thickness under crimping pressures, and therefore transmits this pressure evenly to the center of the crimp area. With this precision-engineered A-MP crimp and BONDED insulation you can be sure of maintaining proper dielectric and tensile values in the finished connection. More intimate contact achieved by confining, over a greater area, terminal and wire under intense crimping pressure.



OTHER IMPORTANT A-MP "FIRSTS"

Completely separate metallic reinforcing ring grips wire insulation, prevents exposure of conductor during sharp bends, cable fatigue caused by flexing and vibration and forms a barrier to foreign objects coming in contact with current carrying members. New helical tongue design gives maximum strength with minimum weight.

SIZES 8 THROUGH 4/0

Ampli-Bond Trade-Mark

THE ONLY LARGE SIZE TERMINAL WITH BONDED INSULATION!

WITH INSULATION SUPPORT AND SUPERIOR A-MP CONFINED CRIMP.

10 distinctive and distinguishable features make precision-engineered AMPLI-BOND terminals the best quality insulated termination for copper wire.

- INSULATION WITHSTANDS A MINIMUM OF 6000 VOLTS!
- INNER COPPER SLEEVE FOR STRENGTH AND VIBRATION RESISTANCE
- FULLY INSULATED METALLIC REINFORCING RING GRIPS INSULATION
- COLOR CODED FOR RAPID IDENTIFICATION
- BRAZED BARREL SEAM
- SUPERIOR A-MP CONFINED CRIMP
- INNER BARREL DIMPLED FOR INCREASED TENSILE STRENGTH
- COPPER TERMINAL BODY ELECTRO-TINNED FOR HIGH CONDUCTIVITY
- BONDED INSULATION
- PROOFMARK FOR POSITIVE IDENTIFICATION

Here is a large size terminal that presents to the users of heavy duty wire the same quality connection that has made A-MP famous for PRE-INSULATED type terminals throughout the industry. Write today for information about AMPLI-BOND and new powerful AMP DYNA-CRIMP portable pneumatic-hydraulic crimping tool.

AMP Trade-Mark Reg. U.S. Pat. Off. © AMP

Find out about the new AMP "CREATIVE APPROACH TO BETTER WIRING"

...An evaluation survey without cost or obligation.

Aircraft-Marine Products, Inc.

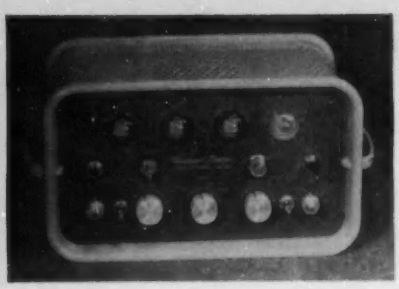
2100 Paxton Street, Harrisburg, Pennsylvania

In Canada . . . . Aircraft-Marine Products of Canada, Ltd.

1764 Avenue Road, Toronto 12, Ontario, Canada

maximum gain of 50 db for input voltages of 0.001 v or less, and lesser gains with higher input voltages. Beckman Instruments, Inc., P.O. Box 296, Station A, Richmond, Calif.

For more information—
Circle 116, inside back cover



Time Interval Meter

This is a time interval meter and frequency standard which uses glow-transfer tubes in the counter unit and a crystal-controlled oscillator as the time base.

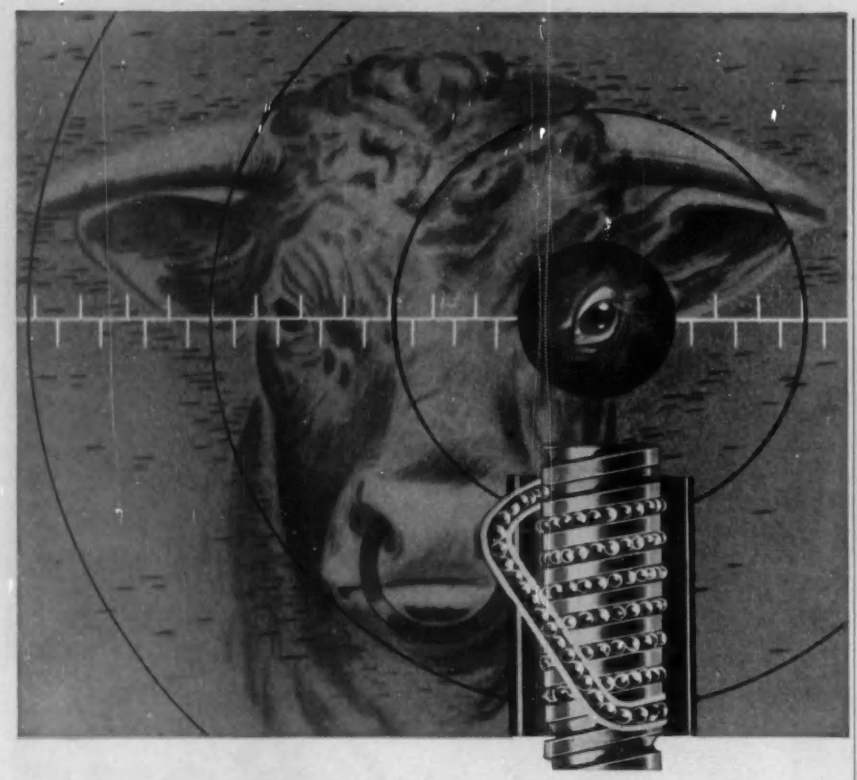
Time is displayed directly to the nearest 0.0001 sec by four easily read decades. Two ranges of 1 and 10 sec are provided; however, longer intervals are easily noted by watching the thousands decade, or through use of an auxiliary electro-mechanical register.

Size 6 x 6 x 11 in. Weight is 11 lb. Westport Industries, 149 Lomita, El Segundo, Calif.

For more information—
Circle 117, inside back cover

Electronic Pressure Indicator

This unit is designed for use with this manufacturer's transducers to measure transient, recurrent and static pressures as well as acceleration and displacement. The indicator contains a stable high frequency oscillator operating at approximately 12.5 megacycles. The diaphragm of the pressure transducer which serves as a variable ca-



you can achieve
BULL'S-EYE POSITIONING
WITH THIS SCREW THAT ROLLS ON BALLS

Pin-point positioning is possible with an AEROL Ball-Screw mechanism even under the most adverse temperature conditions. Because AEROL Ball-Screws move entirely on friction-free steel balls, they permit an assembly to move effortlessly and to position *exactly* at the desired spot... with no springiness, no drift, no rebound. Because they require no lubrication, they allow you to operate in high-temperature areas without fear of fire and thinned-out grease, and in low-temperature areas without the problems of stiffened grease and sluggish operation.

Because AEROL Ball-Screws are friction-free, their use can greatly increase drive efficiency, allowing you to save on motor size and weight, first cost, space and electricity required.

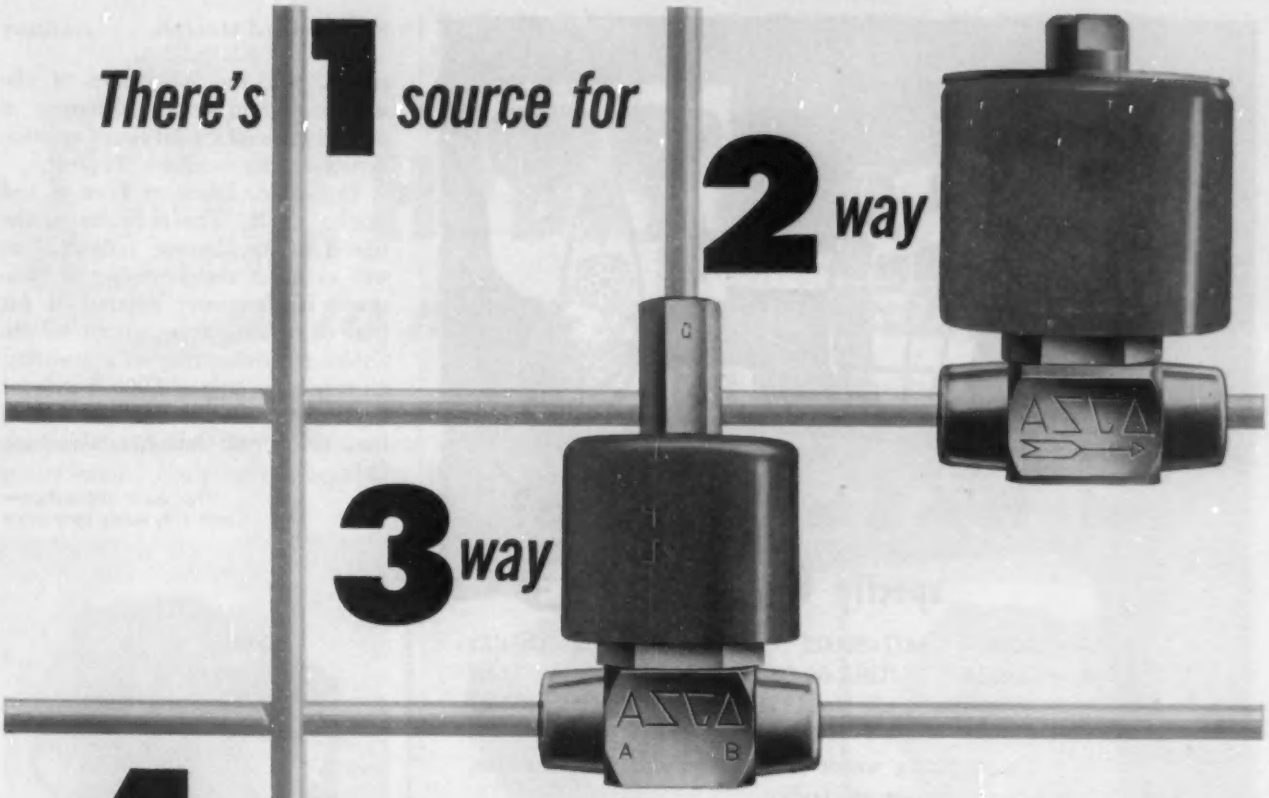
AEROL Ball-Screws are at work now in many varied applications. They have proved to be the best answer to many design and operating problems. They may solve a problem for you. To get more information, write for our free booklet.

Cleveland Pneumatic
Tool Company CLEVELAND 5, OHIO
DEPARTMENT E-555

AIRCRAFT GROUND HANDLING EQUIPMENT
BALL-SCREW MECHANISMS • AIR-OIL IMPACT ABSORBERS

WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS

There's 1 source for 2 way 3 way or 4 way MIDGET SOLENOID VALVES

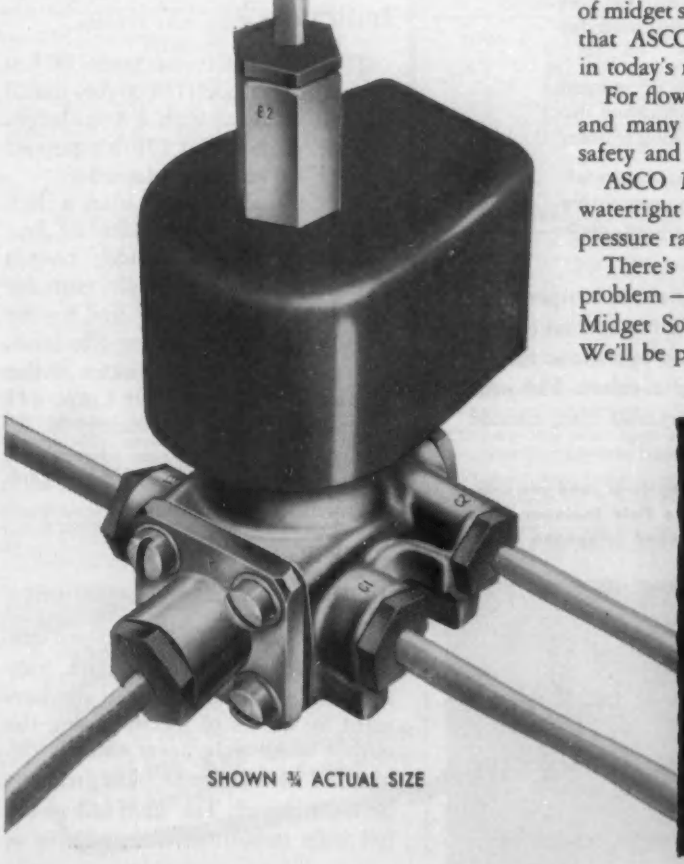


Progressive designers, the men who lead the trend toward miniaturization, depend on ASCO as the one source for a full line of midget solenoid valves. The unexcelled quality and dependability that ASCO pioneered in the solenoid valve field is found, too, in today's midget solenoid valves. Only the size has been reduced.

For flow applications using air, gas, water, light oil, refrigerants and many other liquids, ASCO Midget Valves assure complete safety and truly exceptional performance.

ASCO Midget Solenoid Valves are available with standard, watertight or explosion-proof enclosures. Pipe sizes ⅛" and ¼"; pressure range 0-1000 psi.

There's *one* source that solves virtually any solenoid valve problem – ASCO. Write today for complete data on ASCO Midget Solenoid Valves – or outline any of your requirements. We'll be pleased to assist you.



SHOWN ¾ ACTUAL SIZE

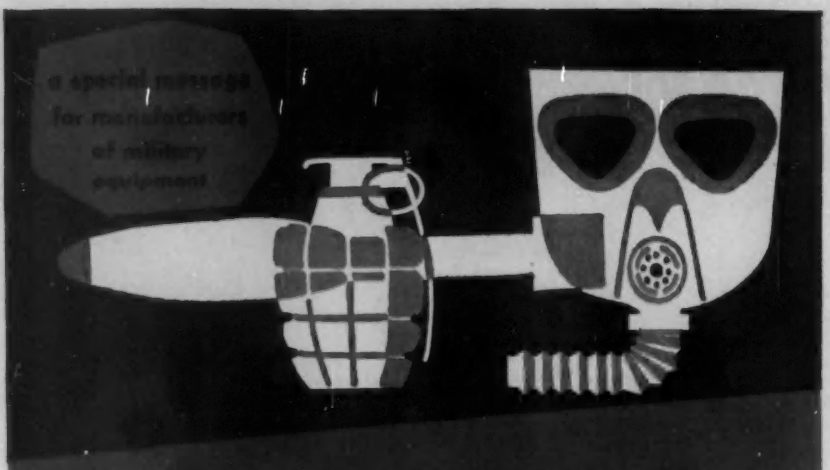
ASCO®

Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

Automatic Switch Co.

385 Lakeside Avenue • Orange, New Jersey

a special message for manufacturers of military equipment



need a finish to beat these specs?

specify IRIDITE®

AN-C-170 MIL-S5002 MIL-C-5541 AN-P32
AMS-2402A USA-50-80-11A J.Q.D. No. 144B
USA 57-93-2A O.S. No. 1374 USA 57-0-2C AN-P61
A-XS-1607 QQ-P-416 QQ-Z-325 MIL-3151—
if you're finishing under these or similar specifications, here's how you can use Iridite:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER... Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

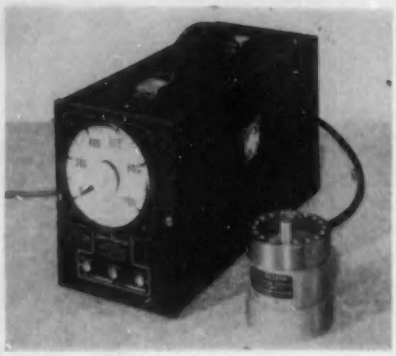
WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

pacitor and the inductance of the matching transformer comprise a parallel resonant circuit tuned approximately to the oscillator frequency.

The device takes up ¼ cu ft and weighs 13 lb. The indicator is designed for oscilloscope indication as well as direct meter reading of pressures. Its frequency response is flat from dc to 300,000 cps within −2 db. Cables for connecting with transducers may be as long as 2,000 ft without requiring special adaptors. Rutico, Inc., 490 S. Fair Oaks Ave., Pasadena, Calif.

For more information—
Circle 118, inside back cover



Remote Pressure Indicators

These indicators are made in two models; the Model 168 makes use of a precision meter with a 3 in. length of scale. The Model 170 is equipped with a 7-in. circular scale meter.

Both models operate from a 105-130 v, 60-cycle, single-phase a-c line. These indicators include built-in regulated d-c power supply units for furnishing the power required for the complete system including the strain gage bridge in the transmitter in this system. Taber Instrument Corp., 111 Goundry St., N. Tonawanda, N. Y.

For more information—
Circle 119, inside back cover

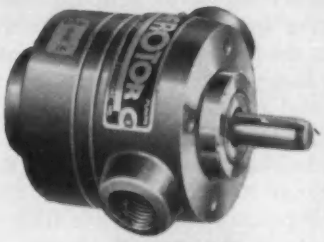
Measures Pressure, Temperature, Displacement

A portable, high speed, self-contained indicator that indicates pressure, temperature, force and displacement by means of pickups using the output of 60-cycle linear variable differential transformers has recently been developed. The unit will give a full scale indication of output for as

THAT FINE LINE OF PERFECTION

There's a GEROTOR HYDRAULIC PUMP to meet your requirements!

The GEROTOR line of precision engineered hydraulic pumps is designed to fill the requirements of the majority of hydraulic equipment users. The three standard GEROTOR models cover a range of g.p.m. delivery from .4 g.p.m. to 40 g.p.m. Check the selection data for the pump to fill your needs.



TYPE QDB

Gerotor's NEW QDB series of small capacity pumps . . . the last word in precision engineering.

DELIVERY G.P.M. — 1800 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

Selection Data

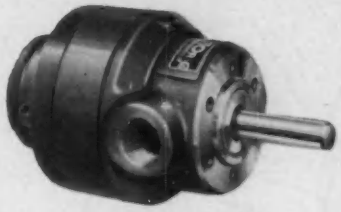
HORSEPOWER REQUIRED — 1800 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.08	.16	.24	.33	.41
QDB .75	.13	.27	.41	.56	.71
QDB 1.5	.16	.42	.70	1.00	1.28

PRESSURE—Maximum continuous operating pressure is 1000 p.s.i.

SPEED—Standard design speed is 1800 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.



TYPE QDH

The QDH . . . popular intermediate size of the Gerotor line

DELIVERY — G.P.M. AT 1200 R.P.M.							
TYPE	DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	3.3	3.2	3.1	3.0	2.9	2.7	2.5
QDH 5	5.6	5.4	5.3	5.2	5.1	4.8	4.4
QDH 8	8.6	8.5	8.4	8.3	8.2	8.1	7.8
QDH 12	12.9	12.8	12.7	12.5	12.3	12.2	11.8

Selection Data

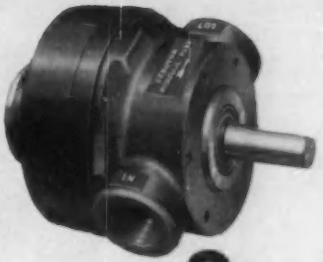
HORSEPOWER REQUIRED AT 1200 R.P.M.							
TYPE	DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	.25	.7	1.2	1.6	2.1	2.5	3.4
QDH 5	.33	1.1	1.8	2.5	3.2	3.7	4.6
QDH 8	.4	1.5	2.7	4.2	5.4	6.3	7.9
QDH 12	.5	2.3	4.2	6.1	8.0	9.6	11.7

PRESSURE—Maximum continuous operating pressure is 1200 p.s.i., maximum intermittent 1500 p.s.i.

SPEED—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is also available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.



TYPE O

Gerotor Series O . . . when larger capacities are needed

DELIVERY — G.P.M. AT 1200 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
O-20	20.0	19.5	18.8	18.0	17.2
O-25	25.0	24.5	24.0	23.2	22.2
O-30	31.2	31.0	30.5	29.8	29.0
O-40	43.0	42.5	42.0	41.5	40.0

Selection Data

HORSEPOWER REQUIRED AT 1200 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
O-20	1.0	4.0	7.2	10.5	13.5
O-25	1.5	5.0	8.8	12.0	15.6
O-30	2.0	6.5	10.9	15.5	19.5
O-40	3.0	9.0	15.0	21.0	27.5

PRESSURE—Maximum continuous operating pressure is 1000 p.s.i., except type O-40, which is recommended for only intermittent duty at 1000 p.s.i.

SPEED—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.

Whatever your needs in hydraulic pumps . . . consult the GEROTOR engineers. Write for FREE literature and information, no obligation, of course.

GEROTOR MAY CORPORATION
1511 Maryland Ave., Balto. 3, Md.

GEROTOR

HYDRAULIC PUMPS — HYDRAULIC MOTORS

Pneumatic Bin Evacuators — Precision Contract Manufacturing

ACE®

Controlled-property compounds meet your needs for:

MECHANICAL,

ELECTRICAL,

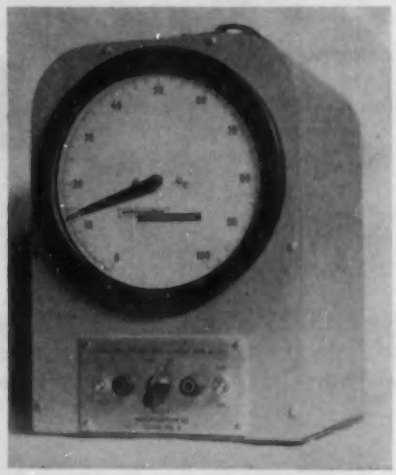
CHEMICAL APPLICATIONS

COME to think of it, we're a little amazed ourselves at the way Ace engineers can blend the mechanical, electrical and chemical properties of different rubber and plastic materials. Their aim is always to find the one best material for each of your jobs . . . never *over*designed . . . with production economy a must. Result: hundreds of tailor-made rubber, plastic, and rubber-plastic alloys to choose from . . . plus many unusual materials like Ace-Tex pyrobitumens. Ask us for anything from rough-ground rods to finished molded assemblies. Our facilities for molding, extruding, fabricating, and lining are among the world's largest.

Always check your ACE design engineer's Handbook when selecting materials for today's production and tomorrow's plans. If you haven't a copy, write today! It's Free.

ACE rubber and plastic products

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.



little as 0.005 in. travel in the external sensing transformer. A pointer indicates the position of the device's cam, and hence the amount of travel in the external transformer. A 7-in. dia dial on the face of the indicator has 200 divisions and is calibrated from 0 to 100 over 300 deg of rotation.

All controls are accessible from the outside of the case, eliminating the need for dismantling except for servicing. The indicator contains a two-position rotary switch on the front of the case to vary the high range sensitivity automatically by a preset amount. A calibration switch is also provided on the front to check the indicator zero at any time without interrupting the process being checked. Schaevitz Engineering, Camden, N. J.

For more information—
Circle 120, inside back cover

Magnetic Amplifier-Type Voltage Regulators

A line of voltage regulators for both single and variable frequency alternators is said to employ no tubes or moving parts. No warm-up time is required. These units work into the field of the exciter or the field of the generator. They can also be used in series or shunt with the generator output. The power for the regulator can be derived from an external power source of any frequency from 50 to 1000 cycle or in case of an a-c generator, from the generator output itself.

These regulators cover alternator ranges from 100 w to 100 kw, 50, 60, 400 and 800 cps and variable frequency of 50 to 70, 350 to 450 and 300 to 1000 cps. Voltage regulation of 0.5 per cent from no-load to full load

Use WELDED STEEL for Greater Strength with Less Weight!

Precision machining operations on heavy cumbersome pieces, such as the base and cover of a 200,000 kw Steam Turbine illustrated above, are not uncommon in the Steel-Weld Division of the Mahon Company. Mahon service to manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment is complete in every respect: Design-engineering, Fabrication, Magnetic and Radiographic Inspection, Stress Relieving, Grit Blasting, Machining and Assembling. If you use weldments in your product, or if parts of your product could be produced to better advantage in welded steel, you will find in the Mahon organization a unique source . . . a source where design skill and advanced fabricating technique are supplemented by craftsmanship which assures a smoother finer appearing job embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or write for Booklet showing Mahon facilities and capabilities in this field.

THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

AIR MOTORS

- Operates on air pressures of 5 P.S.I. to 200 P.S.I.
- Electric control either momentary or maintained. 110 V-AC or low voltage.
- Air control for either bleed or pressure operation.
- One inlet and one exhaust.
- Speed control in both directions. Cushion at both ends.
- Automatic return stroke in one or both ends.
- Swivel, foot, nose, trunion, flange and other mountings.
- BORES: 1½"—2"—3"—4"—5". • STROKES: ½" to 72".
- Sealed-in lubrication. *(Pat. Applied for)*

Write for fully descriptive catalog

Nation-wide sales and engineering service

Lehigh INC.

ENGINEERS AND MANUFACTURERS
1510 Lehigh Drive
EASTON, PENNA.

A FULL LINE OF AIR CONTROL EQUIPMENT

is available with a response time of 0.1, 0.2 or 0.3 sec. Mag-Electric Products, Inc., 12822 S Yukon Ave., Hawthorne, Calif.

For more information—
Circle 121, inside back cover

Germanium Rectifier D-c Power Supply

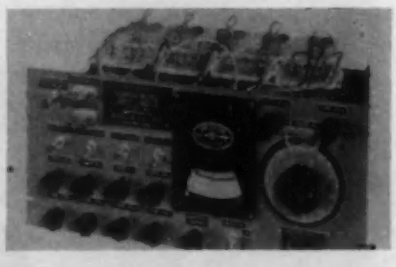
This tubeless unit contains no moving parts and provides inherent regulation of 4 per cent from no-load to full-load. D-c output is 125 v at 25 amp, continuous, a-c input is 230 v, 60 cycle, three-phase. Weight is 125 lb. Dimensions are 22 x 15 x 19 in. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

For more information—
Circle 122, inside back cover

Parliamentary Rules On a Slide Rule

This slide rule settles questions of parliamentary procedure for committees and meetings operating under standard rules of order. Made of durable rigid vinyl sheet, the transparent slider provides immediate answers to eight basic questions on 36 possible motions. This slide rule is based on "Robert's Rules of Order Revised." Pan-L-View, Room 235, 708 Church St., Evanston, Ill.

For more information—
Circle 123, inside back cover



Calibrated Millivolt Supply

This supply provides a calibrated voltage from 0 to 100 millivolts to be used as auxiliary circuitry with electronic self-balancing potentiometer recorders and in similar instrumentation applications. Examples of use are suppressing thermocouple signals so that they can be read on a 0 to 10 millivolt electronic self-balancing potentiometer recorder and supplying the

Profit with papers by Mosinee

Find out how you can get "MORE PROFITS with PAPER"—for laminations, insulation, packaging, protection, fabricating or processing

Mosinee impregnating papers replace steel—when treated with synthetic resins to form light, strong, better insulated refrigerator door panels. Mosinee works with many manufacturers to develop impregnating papers of special qualities. In this case, characteristics desired are strength and moldability to take deep draws.

Mosinee patented reinforced paper simplifies building construction. Easy to handle Mosinee reinforced papers with steel mesh reinforcing attached, replace wood forms for pouring lightweight concrete floors. This is only one of many instances in which Mosinee cooperated in developing new papers to improve processing or production.

THAT's the theme of a growing number of concerns and industries who have worked with Mosinee experts. They've found Mosinee's more than a quarter century of experience particularly valuable in developing special papers to perform specific functions. They've discovered that Mosinee special papers help complete their product or process faster, easier and usually at less cost.

If you'd like to get a general idea of how Mosinee special papers can be developed or adapted to solve your particular product, production or packaging problems — write or see your Mosinee representative. Find out how you, too, can profit more with papers by Mosinee.

Cable wrap of special Mosinee paper winds easily, twists uniformly. Mosinee moisture resistant, extra-strong, electrical cable wrap offers a plus value. Mosinee specialized production controls insure uniformity, minimize problems in high speed twisting and cable wrap operations.

MOSINEE PAPER MILLS COMPANY
DEPT. PE, MOSINEE, WISCONSIN

Mosinee

— specialist in industrial paper technology — makes fibres work for industry.

"powder to part"

Quality Controlled Fluorocarbon Plastics

U.S.G. quality control extends through every operation in the fabrication and custom molding of parts from duPont TEFLON, Kellogg KEL-F and BAKELITE fluorothene.

This quality control insures uniform electrical, chemical and physical characteristics of the highest quality. It also assures uniform density and dimensional stability permitting superior accuracy and dependability in the finished part.

Get the advantages of these fluorocarbon plastics at their best. Whether your requirements are for sheets, rods, tubing, tape, bars, cylinders, beading, electrical spaghetti, or parts extruded, molded or machined to your specifications . . . see U.S.G.

Write for Bulletin No. 300.

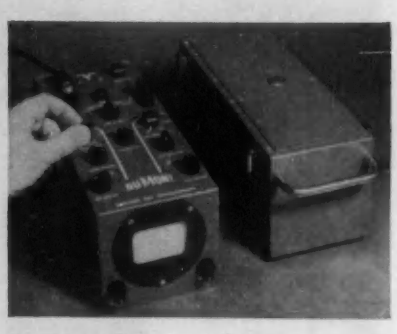
UNITED STATES GASKET COMPANY
Camden 1, New Jersey

USG

FABRICATORS OF FLUOROCARBONS & OTHER PLASTICS
Representatives in principal cities throughout the world

voltage for position-indicating potentiometers. Supply can be used continuously for 8 hr or more. Dimensions are 8¾ x 19 x 13⅛ in. Kahn & Co., Inc., 541 Windsor, Hartford 1, Conn.

For more information—Circle 124, inside back cover



Battery-Operated Transistor Oscillograph

This oscillograph employs practical transistors throughout instead of conventional vacuum tubes. The response of the instrument is 20 cycles to 150 kc, down three db. Sensitivity is 200 mv per in. through the high impedance input and 500 mv per in. through the low impedance input. The unit has a rise time better than 2 microseconds and a writing rate from 3 to 100,000 microseconds per in. Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

For more information—Circle 125, inside back cover

Eight Channel Oscillographic Recorder

This recorder has a frequency response which is flat within ±3 per cent from zero (dc) to 900 cps. Waveforms are scribed as a transparent line on blackened 35 mm acetate film stock by galvanometer-actuated styli, which produce a high definition trace of constant width. No photographic processing is required.

Eight information recording channels or traces are provided, plus a ninth solenoid-actuated channel for timing or reference marking. Total recording times range from 40 to 5 min. The recorder weighs approximately 40 lb. Technology Instrument Corp., Acton, Mass.

For more information—Circle 126, inside back cover

Why Put Up With These Problems in Your Drafting Room?

Your Bruning Man Can Help You Solve Them With Hamilton Auto-Shift Tables

Let your Bruning Man show you how the unique design of Hamilton Auto-Shift Tables not only can help you solve present problems but also allow for orderly, integrated expansion.

How Auto-Shift increases space and operating efficiency

Auto-Shift combines a board and reference desk in one unit to make more effective use of space. When used in row installation, as pictured at the left, Auto-Shift puts a large reference surface and drawer directly behind each draftsman for even greater space and operating efficiency. To check reference material, the draftsman need only turn in his chair and slide the reference surface toward him. Over conventional desk-next-to-board arrangements, this Auto-Shift feature saves time and floor space.

How Auto-Shift reduces draftsman fatigue

Auto-Shift provides convenient foot and hand releases for instant, effortless one-man adjustment of height and slope. Counterbalanced top allows finger-tip control of slope. Draftsman can change position often and yet reach any part of the board without strain whether seated or standing. He works faster and easier; production rate goes up!

See for yourself how the advantages of Auto-Shift can increase space and operating efficiency in your drafting room. Mail the coupon below for detailed information.

NEW
HAMILTON ECONOMY STEELWOOD TABLES

Here's new economy in a quality steel and wood table! No. 1 Select Basswood, highly sanded, drawing surface. Sturdy steel legs and feet. Convenient drawer space and raising device. Priced as low as $89.00. See your Bruning Representative or write us, today, for prices and specifications.

BRUNING

Everything for the Engineer, the Architect, and the Draftsman

Charles Bruning Company, Inc., 4700 Montrose Ave., Chicago 41, Ill.

Charles Bruning Company, Inc.
4700 Montrose Ave., Chicago 41, Ill., Dept. 1414

Please send me information on Hamilton Auto-Shift Tables.

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

SELF LUBRICATING BEARINGS by

Detroit Sintered Metals

These powdered metal bearings and bushings supply the proper amount of oil, all the time, to mating surfaces under all operating conditions. This eliminates maintenance costs such as frequent oiling or the replacement of burned out bearings. It also lengthens the useful life of machines. Let us quote on your next order for powdered metal bearings or bushings. We produce them to close tolerances in porous bronze, porous iron-copper or porous iron. Our deliveries are fast . . . our quality excellent.

FREE!

Here is an illustrated folder, full of useful data, that is yours for the asking.

DETROIT SINTERED METALS CORPORATION

18434 Fitzpatrick Ave.
Detroit 28, Mich.

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

Electronic Timers—Bulletin, 5 pp, includes delay, repeat cycle and interval times. G. C. Wilson & Co., 1950-8 Ave., Huntington, W. Va.

Circle 127, inside back cover

Relays—Catalog, 72 pp. Each relay is fully described as to physical and electrical characteristics, also complete operating data and suggested applications are included. A-c and d-c relays include sensitive, heavy duty, midget, telephone type, general purpose, snap switch and interchangeable aircraft relays. A-N approved relays; sub-miniature relays; special relays, components and assemblies are shown. Two pages are devoted to definitions of engineering and electrical terms and laws. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

Circle 128, inside back cover

Cellulose Padding—Sample and data kit describes fabrics used for cushioning, padding, protective covering which are made of combinations of cotton, wool, cellulose and other fibers. Wood Conversion Co., First National Bank Building, St. Paul 1, Minn.

Circle 129, inside back cover

Wire—Wall chart gives split gages in decimal sizes. Mettler Machine Tool, Inc., Adeline St., New Haven, Conn.

Circle 130, inside back cover

General Purpose Rotary Pumps—Catalog B, 36 pp, describes reversible pumps of ½ to 200 gpm ratings. Viking Pump Co., Cedar Falls, Iowa.

Circle 131, inside back cover

Instruments and Controls—Catalog 5002, 24 pages, pyrometers, indicators, thermometers, gages, meters and other such devices. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Avenues, Philadelphia 44, Pa.

Circle 132, inside back cover

Industrial Slides—Folder, 6 pp, contains photographed applications and lists variables of slides. Grant Pulley & Hardware Corp., 31-85 Whitestone Parkway, Flushing 54, N. Y.

Circle 133, inside back cover

Color-Coded Compression Terminals—Bulletin 55Y1, 10 pp, describes ferrules for grounding shielded wire and coaxial cable, terminating rod-type heating element studs, and splicing solid and stranded wire. Contains a dimensional chart in seven colors. Burndy Engineering Co., Inc., Norwalk, Conn.

Circle 134, inside back cover

Nylon Pressure Tubing—Bulletin, 6 pp, has data on characteristics and properties. Sizes and lengths are also given. Polymer Corp., Reading, Pa.

Circle 135, inside back cover

Roller Bearings—Bulletin H-54, 52 pp, contains a cutaway photograph and a detailed line drawing of each model in each series and includes dimensional and load capacity tables and mounting detail. In addition, there are tables and interchangeability charts. McGill Mfg. Co., Inc., Valparaiso, Indiana

Circle 136, inside back cover

Gearmotors—Bulletin 1001, 16 pp, describes line of single, double and triple reduction units ranging from 1 to 50 hp. Louis Allis Co., Milwaukee 7, Wis.

Circle 137, inside back cover

Electric Motors—Bulletin 401, 4 pp, describes line of completely enclosed motors. Baldor Electric Co., 4353 Duncan Ave., St. Louis 10, Mo.

Circle 138, inside back cover

Polarized D-C Relays—Bulletin F 3961-4, 4pp, describes operation on input powers as low as 50 microwatts. Barber-Colman Co., 1300 Rock St., Rockford, Ill.

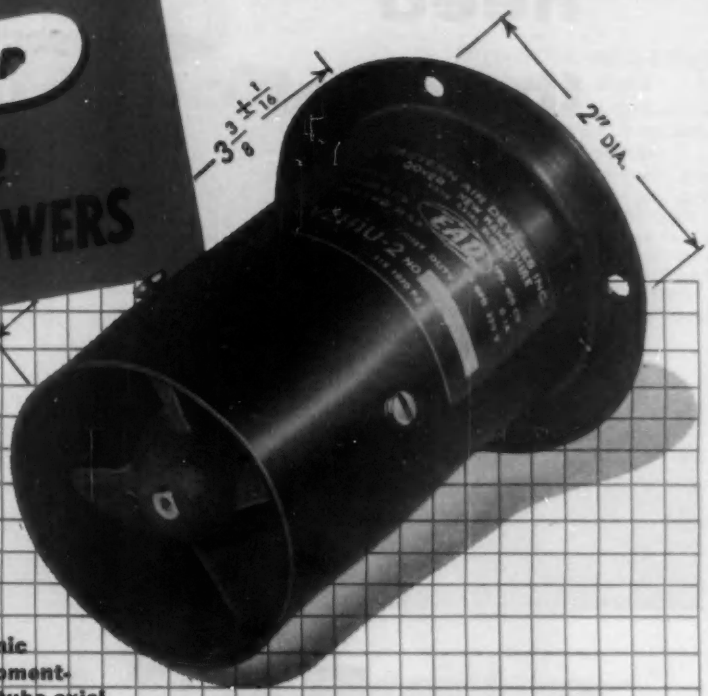
Circle 139, inside back cover

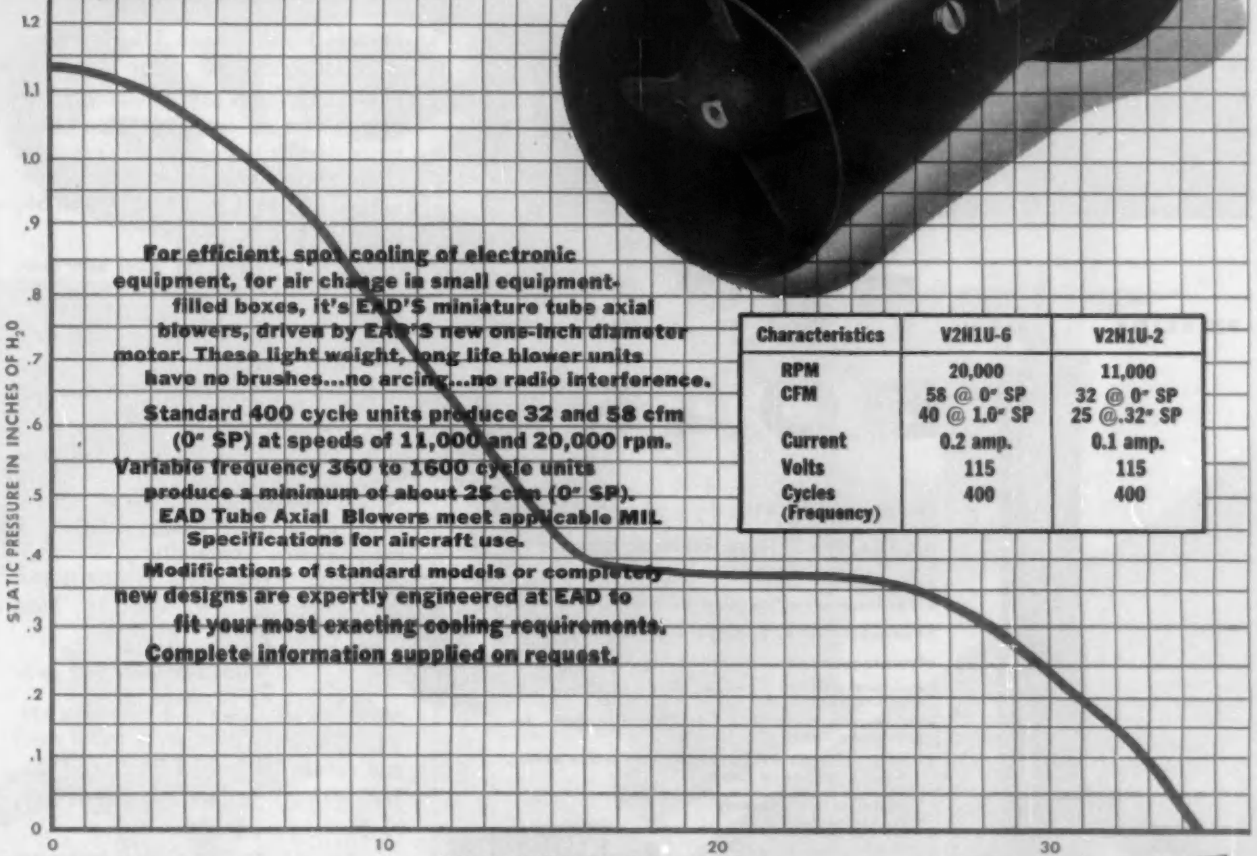
O-Rings and Molded Parts—Catalog, 24 pp, includes service recommendations, dimensional data for installation of O-rings, packings and characteris-

High CFM even with HIGH SP

(static pressure)

EAD miniature TUBE AXIAL BLOWERS



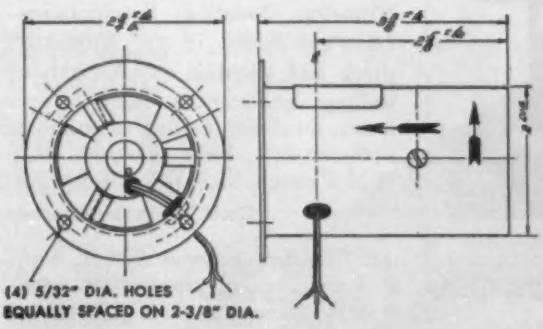


For efficient, spot cooling of electronic equipment, for air change in small equipment-filled boxes, it's EAD'S miniature tube axial blowers, driven by EAD'S new one-inch diameter motor. These light weight, long life blower units have no brushes...no arcing...no radio interference.

Standard 400 cycle units produce 32 and 58 cfm (0" SP) at speeds of 11,000 and 20,000 rpm. Variable frequency 360 to 1600 cycle units produce a minimum of about 25 cfm (0" SP). EAD Tube Axial Blowers meet applicable MIL Specifications for aircraft use.

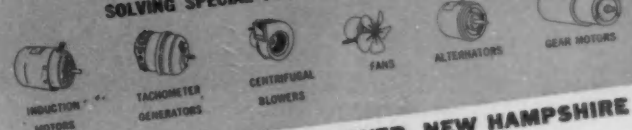
Modifications of standard models or completely new designs are expertly engineered at EAD to fit your most exacting cooling requirements. Complete information supplied on request.

Characteristics	V2H1U-6	V2H1U-2
RPM	20,000	11,000
CFM	58 @ 0" SP 40 @ 1.0" SP	32 @ 0" SP 25 @.32" SP
Current	0.2 amp.	0.1 amp.
Volts	115	115
Cycles (Frequency)	400	400



EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD



381 CENTRAL AVENUE, DOVER, NEW HAMPSHIRE

does your product need thermal control?

amazing . . . new **FESCO® BOARD**

is a rigid, sturdy, thermal and acoustical insulation board

- High insulation efficiency—"K" factor of .296 @ 75°F.
- Fire-proof — mineral composition, won't burn
- Permanent — won't rot, mildew or deteriorate
- Moisture-resistant — cellular glass membranes block moisture penetration
- Structurally strong — rigid, stable, yet easily cut for production sizes
- Analysis — composed of expanded Coralux perlite, mineral binders and fibers
- Lightweight — weighs only 8-oz. per board foot

Write for sample,
additional technical data
or laboratory assistance

F. E. SCHUNDLER & CO., INC.
C-1 304 RAILROAD STREET, JOLIET, ILLINOIS

tics of polyvinyl products. Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif.

Circle 140, inside back cover

Blind Rivets—Booklet TL-99, 8 pp, shows how the blind rivets work, how they are used in manufacturing, maintenance and repair work, and provides detailed information on stock items. Townsend Co., New Brighton, Pa.

Circle 141, inside back cover

Single-Turn Potentiometer—Data sheet, 2 pp, describes construction, specifications and linear coil characteristics. Helipot Corp., 916 Meridian Ave., Pasadena, Calif.

Circle 142, inside back cover

Ductile Iron—Bulletin DI-25, 30 pp, is illustrated with more than 40 photos. Includes case histories, specification tables for the seven main types of ductile irons and charts comparing mechanical properties. International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Circle 143, inside back cover

High Alloy Castings—Bulletin 3354-G, 16 pp, gives engineering data concerning castings used for resisting high temperatures, corrosion and abrasion. Duraloy Co., Scottdale, Pa.

Circle 144, inside back cover

Nickel Copper Steels—Booklet, 48 pp. describes working methods, mechanical properties, compositions and availability of seven steels. International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Circle 145, inside back cover

Sheet Metal Cases and Covers—Catalog, 35 pp, describes sheet metal cases and covers. Hudson Tool & Die Co., Inc., 118-20 S. 14th St., Newark 7, N. J.

Circle 146, inside back cover

Vibration Isolation Specifications—Looseleaf sheets, 10 pp, summarizes shock and vibration requirements of military specifications, such as resonance, durability, cycling, crash safety, performance. Barry Controls Inc., 1000 Pleasant St., Watertown, Mass.

Circle 147, inside back cover

Air Cylinders—Bulletin A-105K, 8 pp, describes design, construction, engineering, mounting and dimensional

PROOF

THAT YOU GET MORE MOTOR

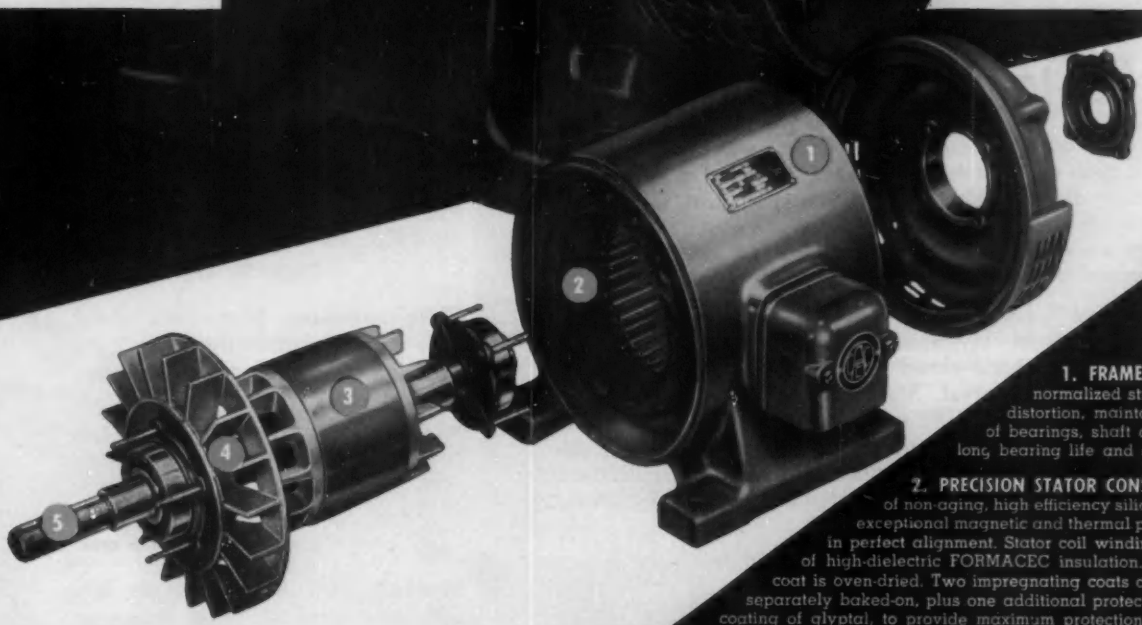
ACEC

OPEN DRIP-PROOF MOTORS

FIELD-TESTED, FIELD-PROVEN FOR OVER 70 YEARS

Acceptance of ACEC motors is the result of *quality* engineered into every component . . . rigidly *controlled* at every step of manufacture . . . and *proven* by years of rugged field use. Amazingly, they cost less and they continue to cost less in maintenance, down-time and replacement. ACEC motors are a guarantee of long, trouble-free service.

Compare the prices of ACEC motors and those you've been buying. See how the most modern manufacturing methods give more motor for less money.



1. FRAME is rigid cast-iron normalized stress-relieved against distortion, maintains perfect alignment of bearings, shaft and end bells, assuring long bearing life and quiet operation.

2. PRECISION STATOR CONSTRUCTION of non-aging, high efficiency silicon steel, with exceptional magnetic and thermal properties, secured in perfect alignment. Stator coil windings are of high-dielectric FORMACEC insulation. First plastic coat is oven-dried. Two impregnating coats are separately baked-on, plus one additional protective coating of glyptal, to provide maximum protection against oil, moisture and chemicals — under all operating conditions.

3. SKEWED ROTORS — dynamically balanced rotor (in two planes) exceeds NEMA standards, reduces noise, vibration, and wear, guarantees maximum electrical and mechanical efficiency through the complete speed and load range.

4. TURBINE-TYPE FAN assures lowest operating temperatures.

5. SHAFT forged of high tensile steel, precision ground.

ACEC motors are available for immediate delivery from stocks warehoused in your area. For more information, call your ACEC field engineer or one of the 285 Authorized ACEC Distributors in the U.S. and Canada.

Write for our new bulletin on any of the following motors: O.D.P — T.E.F.C. — V.H.S. — Explosion-Proof — Gear — Wound Rotor — Synchronous — Variable Speed.

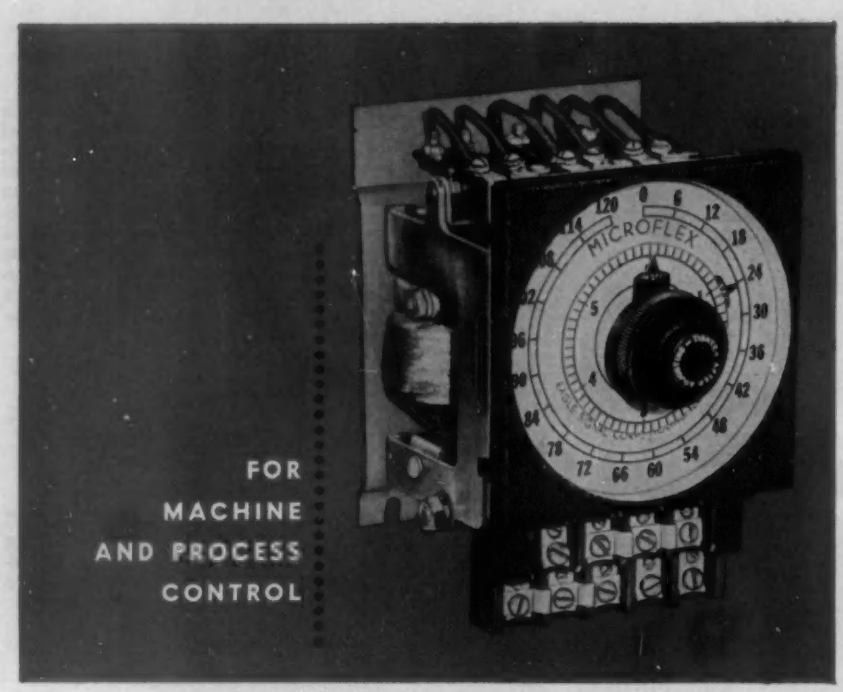
NEMA standards, plus!

ACEC ELECTRIC CORPORATION

40 E. 49th St., New York 17, N. Y. *OFFICES IN PRINCIPAL CITIES*

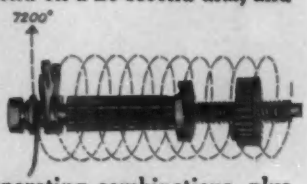
53-8

EAGLE
Microflex Reset Timer



Insures "20-to-1 ratio" accuracy

Time settings of pinpoint accuracy are a reality, thanks to the Microflex double dial. It takes one complete turn of the *inner* dial to advance the *outer* dial just one division. That's a 20-to-1 ratio, made possible by the patented Microflex threaded axle and pinion (see sketch). Examples of resultant accuracies are ± 1/60 of a second on a 20-second dial, and ± 1/10 of a second on a 120-second dial.



The Microflex Reset Timer is driven by a heavy-duty industrial synchronous motor. Contacts are tripped closed or open after a preset time interval. Starting and resetting are electrically controlled. Microflex offers over 150 timer operating combinations, plus a wide range of long or short time periods. It's ideal for applications like molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for free Automation Booklet and Bulletin 110.

MAIL COUPON TODAY

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. PE-555
MOLINE, ILLINOIS

Please send free Automation Booklet and Bulletin 110 containing complete data on Microflex Reset Timers.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

data on 200 psi heavy duty cylinders. Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

Circle 148, inside back cover

Hydraulic Cylinders—Bulletin H-104K, 8 pp, discusses line of heavy duty, 2000 psi cylinders, providing design, engineering, construction, mounting, dimensional and operational data. Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

Circle 149, inside back cover

Machinery Mounts—Bulletin 546, 8 pp, giving summary of mounts engineered for applications on various types of machines. Barry Controls Inc., 1000 Pleasant St., Watertown, Mass.

Circle 150, inside back cover

Miniature Capacitors—Bulletin 337-8, 6 pp, includes tables of capacitance values and voltage ratings, dimensional drawings, and typical curves. Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

Circle 151, inside back cover

Synchronous Motors—Catalog El-4A, 24 pp, describes over 125 hysteresis and salient pole induction synchronous motors. Performance curves and characteristics are given for single, dual, three and five-speed hysteresis models for operation at frequencies from 30 to 400 cycle. Electric Indicator Co., Inc., Springdale, Conn.

Circle 152, inside back cover

Phosphor-Bronze Strip—Data sheet 101, 4 pp, describes thin-gage, high-precision tolerance strips, including physical characteristics, temper, mill limits, available thickness tolerances and applications. American Silver Co., Inc., 36-07 Prince St., Flushing 54, N. Y.

Circle 153, inside back cover

Standards—1955 Edition, 48 pp, lists and indexes about 1500 American standards. There are 210 for construction and civil engineering, 153 mechanical, 272 electrical, 158 safety, 165 textiles and wearing apparel, 251 photography and motion pictures, 74 petroleum products, 69 chemical, 62 metallurgy, 38 gas-burning appliances, 32 drawings, letter symbols and abbreviations, 18 mining, 11 rubber, 10 office equipment and supplies, as well as others. A separate section on con-

Small Size!

OHMITE® axial-lead vitreous-enameled resistors

18 SIZES—1 to 15 WATTS*
3/16", 1/4" and 5/16" diameters—1/2" to 1-3/4" lengths

If you want a compact, wire-wound resistor for your tough jobs, specify Ohmite axial-lead resistors. These power-type units are designed to stand up under high temperatures. All parts—core, resistance wire, vitreous-enamel coating, and terminal bands—are "thermally balanced" to expand and contract as a unit. Terminals remain firmly anchored, cracking is eliminated, and moisture cannot enter the resistor.

ACTUAL SIZE

*The rating for any one size is determined by the maximum operating temperature as specified by Underwriters' Laboratories, RETMA, or MIL-R-26B.

OHMITE RESISTORS HAVE BALANCED THERMAL EXPANSION

1 WELDED TERMINALS— Provide perfect and permanently stable electrical connections.

2 STEATITE CORE— Its thermal expansion closely matches all other materials in the resistor.

3 VITREOUS ENAMEL— Exclusive Ohmite formula thermally matches core, terminals, and wire.

Write for Bulletin 147

OHMITE MANUFACTURING COMPANY
3611 Howard St., Skokie, Illinois (Suburb of Chicago)

30th Anniversary
1925-1955

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

FOR HIGH CURRENT

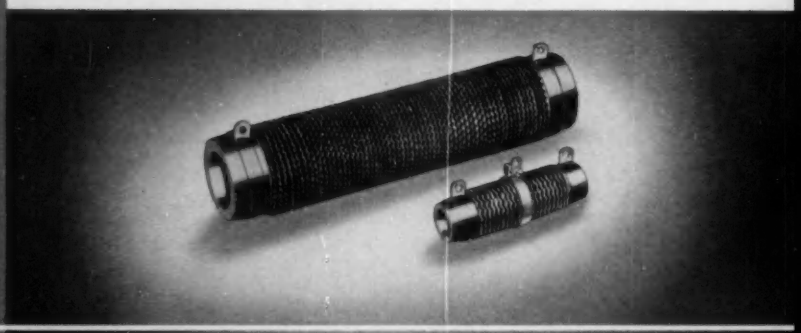
LOW RESISTANCE APPLICATIONS . . .

OHMITE® *Power Type* RESISTORS

CORRIB®

Vitreous-Enameled, Corrugated-Ribbon Type

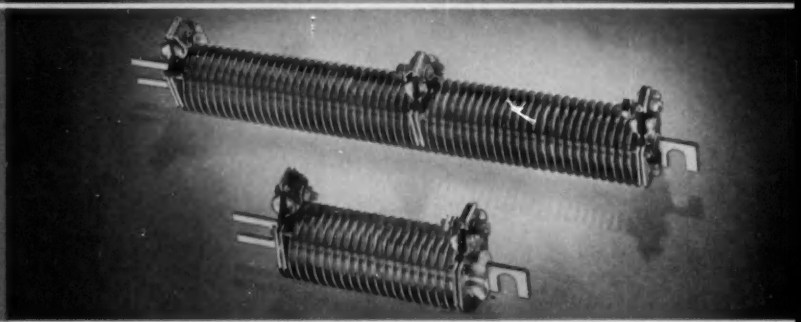
Special Ohmite vitreous enamel locks the edge-wound ribbon alloy to a sturdy ceramic core. Fixed, tapped, and adjustable types. Available in 22 sizes from 90 to 1500 watts. Resistance values range from .04 to 70 ohms.



POWR-RIB

Edgewound-Ribbon Type

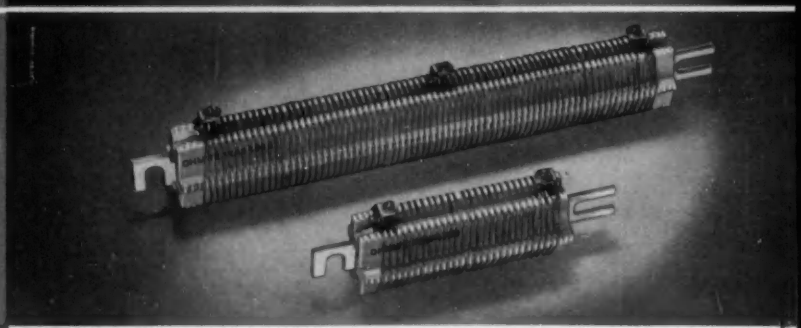
Has a heavy ribbon of resistance alloy, edge-wound on a ceramic core. Core is sectionalized for flexibility and shock resistance. Terminals and brackets are plated to prevent oxidation. Four sizes in resistances from .043 to 1.6 ohms; and from 24 to 95 amperes.



POWR-RIB

Round-Wire Type

Similar in construction to Ribbon-Wire type shown above, but with round resistance wire. Sturdy ceramic core is made in two to five sections. Available in four sizes. Resistance values from .69 to 25 ohms. Current ratings from 5.1 to 18.4 amperes.



Write for Bulletin 144

Available in fixed or adjustable "DIVIDOHM®" Types.

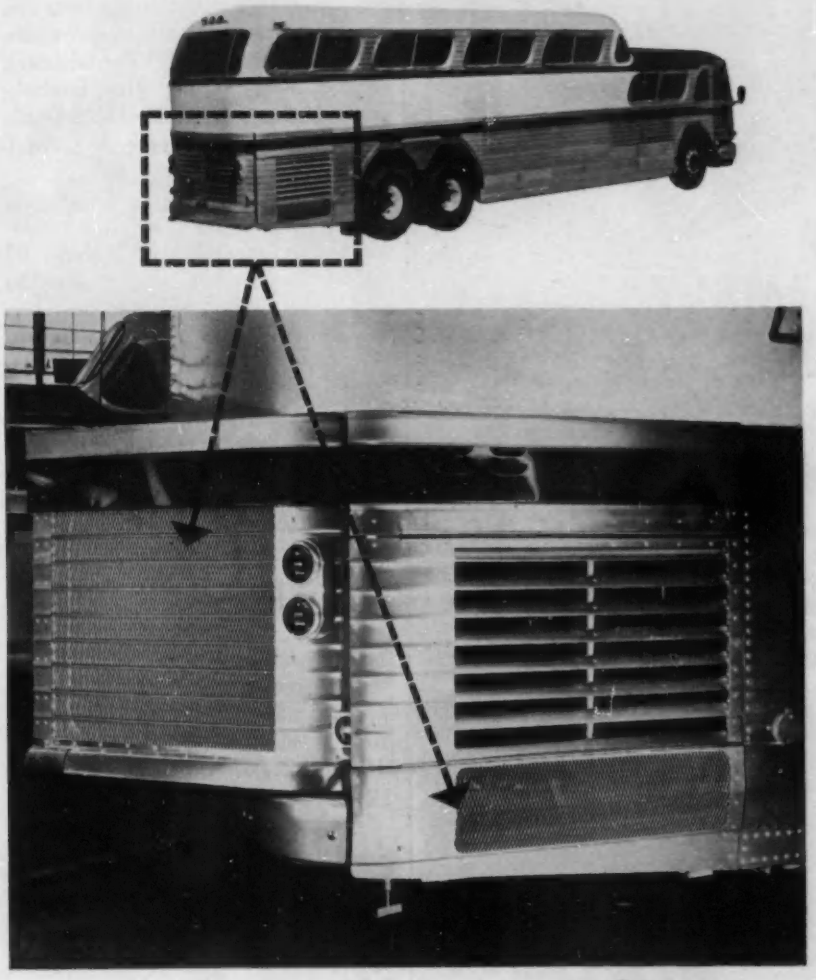
Be Right with OHMITE®

30th Anniversary 1925-1955

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

OHMITE MANUFACTURING COMPANY, 3611 Howard St. • SKOKIE, ILLINOIS (Suburb of Chicago)

DESIGN for lasting beauty and utility with *EXPANDED STAINLESS STEEL*



Shining examples of expanded stainless steel beauty, are the panels for the engine compartment of the large passenger coach shown here.

They're in perfect harmony with the rest of the stainless exterior. And, they are corrosive-resistant, easy-to-clean, durable. What's more, the open mesh permits air to circulate freely.

Penmetal expanded stainless steel is sheet metal that has been slit and expanded to as much as ten times its original width. Up to 80% lighter than solid sheet of the same dimensions, the diamond truss pattern adds rigidity and strength. Also available in carbon steel, aluminum, Monel, Inconel and other metals; large or small mesh; light or heavy gauge.

With its clean modern look, high utility, yet economical cost, Penmetal expanded stainless steel might well be your first step towards new markets and new profits. For details of Penmetal expanded stainless steel, send for new folder 506-EM.

PENN METAL COMPANY, INC.

General Sales Office:
205 East 42nd Street, New York 17, N. Y.
Plant: Parkersburg, W. Va.

EXPANDED STAINLESS STEEL shelf in low temperature refrigerated water bath. The exterior expanded metal is of carbon steel.

PM-71

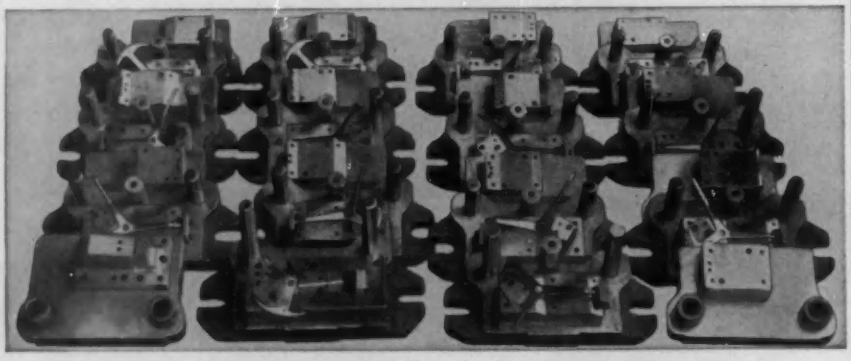
Engineers!

ELIMINATE ASSEMBLY PROBLEMS WITH . . .

PRODUCTION B. Jahn PROVED DIES

Two . . . three . . . fifty component dies can be built by B. Jahn — each production proved to guarantee one perfectly fitting, operational assembly.

Modern production requires assemblies — each component demanding a separate tool and die — each having a vital relationship — all needed when you want them. In the modern B. Jahn plant, 165 skilled tool-makers representing 3654 years of experience *work together* developing multiple dies of flawless precision for intricate assemblies.



Part of a set of twenty-eight B. Jahn built precision forming dies, to produce different component levers for one of America's largest calculating machine manufacturers. B. Jahn builds multiple dies as a team — each engineered to do a specific job perfectly.

HERE'S THE WHOLE STORY -

Investigate B. Jahn and Invest in Production Economy!

Send TODAY for "The Story of B. Jahn Production Proved Dies" — a fact-packed brochure illustrating B. Jahn's facilities and their production-increasing, money saving applications.

B. Jahn

THE B. JAHN MANUFACTURING COMPANY, NEW BRITAIN, CONNECTICUT

sumer goods contains its own index. American Standards Assn., 70 E. 45 St., New York 17, N. Y.

Circle 154, inside back cover

Hydraulic Standards—Pamphlet, 20 pp, includes all revisions made at the January 1953 meetings of the Joint Industry Conference. Also included are the recommended practices on hydraulic packings and seals, examples of packing code identification, sample circuit using JIC symbols, glossary of terms. Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

Circle 155, inside back cover

Aluminum Extrusions—Catalog, 60 pp, covers standard shapes, such as angles, tees, channels, rod and bar, tube, molding. It lists sizes, dimensions, weights. Harvey Aluminum, 19200 S. Western Ave., Torrance, Calif.

Circle 156, inside back cover

Vibration Mounts—Booklet, 8 pp, describes mounts and bases for machinery and testing equipment. Federal Shock Mount Corp., 1077 Intervale Ave., New York 59, N. Y.

Circle 157, inside back cover

Metal Hose—Catalog 100, 8 pp, describes hose made of stainless, bronze, Monel, nickel, steel. Cobra Metal Hose Div., DK Mfg. Co., 4640 W. 54th St., Chicago 32, Ill.

Circle 158, inside back cover

Screws, Nuts, Bolts, Pins—Catalog 155, 33 pp, has dimension drawings, tables, giving available sizes and types of fastenings. Chicago Screw Co., Bellwood, Ill.

Circle 159, inside back cover

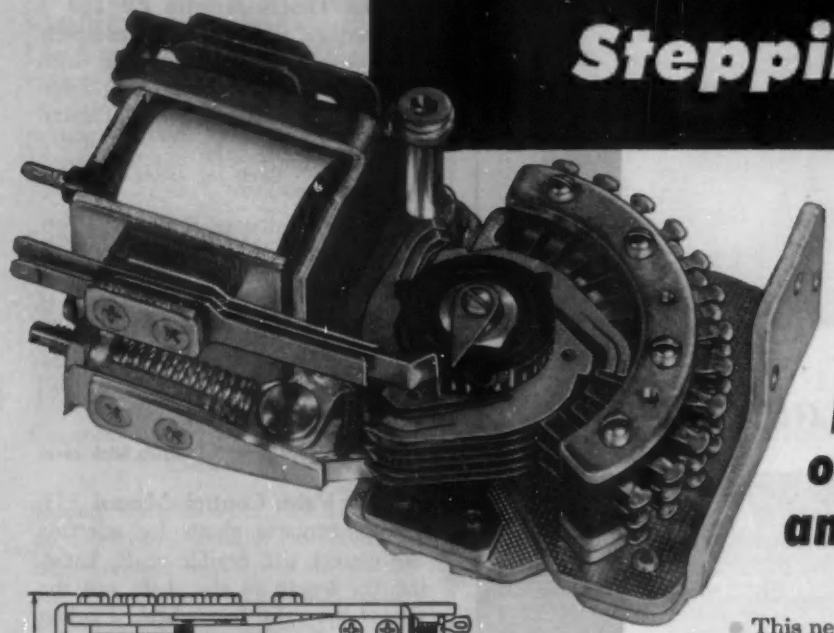
Brazing—Catalog 925, 24 pp, has over twenty tables, drawings and photographic illustrations. The subjects discussed include silver brazing procedure, selection of brazing and filler metals, design of brazed joints, prebraze cleaning, assembly of brazed joints. Air Reduction Sales Co., 60 E. 42 St., New York 17, N. Y.

Circle 160, inside back cover

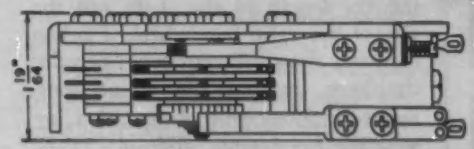
Wrought Iron Pipe—Catalog, 52 pp, has more than 25 separate tables listing size and dimensional data of wrought iron pipe and tubular products. Data is also provided about wire

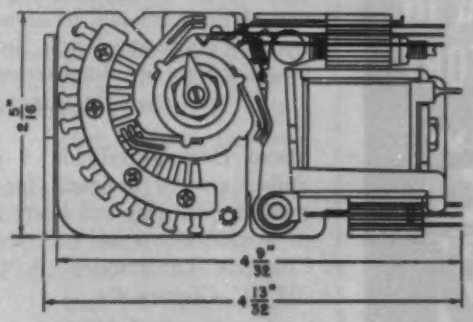
Available NOW!

New CLARE Type 11 Springdriven Stepping Switch



Small, compact design provides millions of steps without any readjustment





This new CLARE Type 11 Springdriven Stepping Switch is the latest in the CLARE line of uniselectors, or rotary switches, for completing, interrupting, or changing the connections in a succession of electric circuits in response to momentary impulses of current.

Like the larger and older switches in the CLARE line—Types 20, 26, 40 and 52—this sturdy, fast-stepping little switch is capable of many different applications, such as:

- *Selecting any desired point in a series*
- *Selecting the first unoccupied point in a series*
- *Sequence controlling: automatically controlling a series of operations in a predetermined manner*
- *Counting and totalizing*
- *Generating timed pulses*
- *Monitoring*

The CLARE Type 11 Switch is designed to be free from critical adjustments. The few adjustment points are unusually easy to reach when required, but choice of materials and design provides millions of steps without any readjustment.

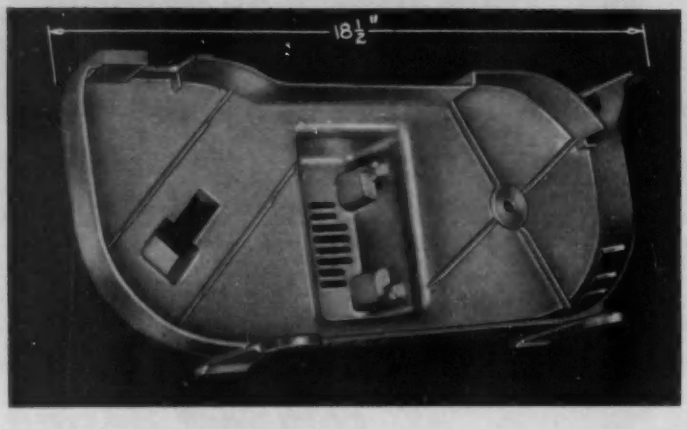
Send for Engineering Bulletin No. 121 for complete information on the new CLARE Type 11. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Small size is illustrated by this cutaway view, showing a three-level switch hermetically sealed in a can commonly used to enclose one CLARE Type C Relay

FIRST in the industrial field

CLARE RELAYS

Die castings that stand out . .



. . . above others

FEDERAL DIE CASTING CO.
2228 N. ELSTON AVE. CHICAGO, 14, ILL.
PHONE ARmitage 6-4803

THE HOTTEST THING IN CARTRIDGE HEATING-UNIT HISTORY

THE NEW WATLOW
FIREROD
CARTRIDGE

5 TIMES MORE HEAT
than ANY standard cartridge heating unit!

A New high in Watt Densities and temperatures . . . plus l-o-n-g-e-r cartridge life.

For convincing test-proof and other information, write for new FIREROD Bulletin.

WATLOW
ELECTRIC MFG. CO.
1392 FERGUSON AVE.
SAINT LOUIS 14, MO.

and sheet metal gages, flow of water in gallons per minute and useful conversion factors. A. M. Byers Co., Pittsburgh, Pa.

Circle 161, inside back cover

Interval Timers–Bulletin PB 210, 8 pp, contains exploded views, complete descriptive and technical data, with wiring, dimension and housing information. R. W. Cramer Co., Centerbrook, Conn.

Circle 162, inside back cover

Die Cast Fasteners–Bulletin, 4 pp, contains illustrations of each type of fastener, diagrams with complete specifications and lists of stock sizes to facilitate selection of the right size and type of fastener. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.

Circle 163, inside back cover

Remote Valve Control–Manual 553, 20 pp, contains charts for selecting the correct size flexible shaft, knowing the length of the shaft and the size of the valve handwheel. Finding diagrams show different types of valve couplings, intermediate connections, remote stations and clamps that are available for flexible shafting. Drawings of the terminals are shown with complete dimensional data. Stow Mfg. Co., 426 State St., Binghamton, N. Y.

Circle 164, inside back cover

Macro Camera–Bulletin, 4 pp, describes camera designed for photographing unwieldy and heavy subjects at magnifications of 1.25 to 24.50. Chapman Laboratories, P. O. Box 207, W. Chester, Pa.

Circle 165, inside back cover

Photoelastic Equipment–Booklet, 12 pp, describes polariscopes, model-making kits, straining frames. Chapman Laboratories, P. O. Box 207, W. Chester, Pa.

Circle 166, inside back cover

Cycling Timers–Bulletin PB-510, 8 pp, describes these timers in detail, complete with time ranges and ratings available, wiring diagrams and dimension drawings, special housings. R. W. Cramer Co., Inc., Centerbrook, Conn.

Circle 167, inside back cover

Gear Sets–Manual DR-2, 30 pp, lists all standard gear sets available by cen-

ter distance and capacity. Also contains material helpful in the selection of gear sets. Foote Bros. Gear and Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.

Circle 168, inside back cover

Nitriding Processes–Booklet, 48 pp. Five graphs and 17 charts help define compositions, mechanical properties and case hardening capabilities of four principal types of special steels. Nitralloy Corp., New York, N. Y.

Circle 169, inside back cover

Tubing for Elevated Temperature and Pressure–Data Card 177 shows chemical analyses of standard carbon, alloy and stainless tubing steels. It is cross-indexed to associate grade and ASTM specifications for the individual tubing steels involved. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 170, inside back cover

Shaped Wire–Booklet DH 1226, 16 pp, describes profiles available in cross-sectional areas up to and including ¼ sq. in., and in flats and rectangles in widths up to ⅜-in., the ratio of width to thickness not exceeding 6:1. These wires are produced in low carbon steels, low alloy steels, high carbon steels, stainless steels and Armco ingot iron, in range of commercial finishes. American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.

Circle 171, inside back cover

Ceramics–Bulletin 551, 4 pp, lists mechanical and electrical properties of technical ceramics. America Lava Corp., Chattanooga 5, Tenn.

Circle 172, inside back cover

Laminated and Molded Plastics–Bulletin, 12 pp, describes more than 35 different types and grades of laminated and molded plastics. Richardson Co., 2662 Lake St., Melrose Park, Ill.

Circle 173, inside back cover

Casters and Wheels–Catalog D-339, 19 pp, covers different types of casters and wheels. Colson Corp., Elyria, Ohio.

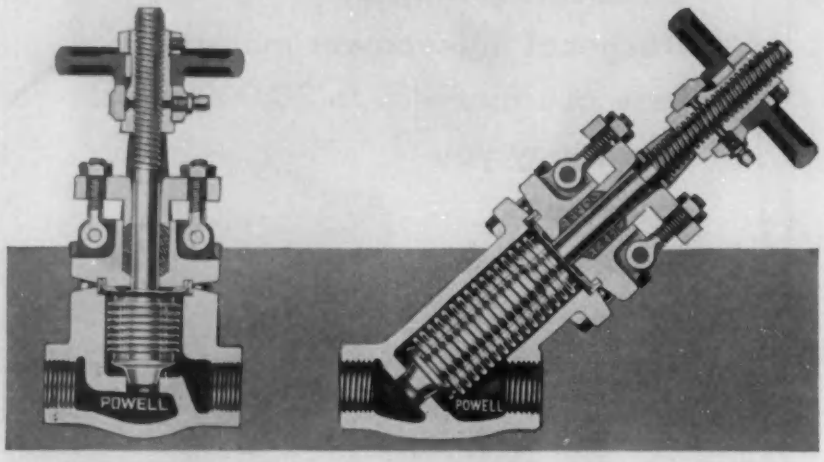
Circle 174, inside back cover

Porous Stainless Steel Filters–Bulletin 213, 4 pp, describes stock filters, prices and application data. Choice of filter area, porosity of filter ele-

This is it!
Newest motor on the market!
If you make any product requiring a fractional horsepower motor (any quantity—20 to 20,000 units) it will pay you to accept our invitation to test run the
new
HOOVER
HY-DRIVE
A completely new FRACTIONAL HORSEPOWER motor
...detailed to order
Compact—More Power per pound. Available with rigid, face or resilient mount as shown here. Split-phase, Capacitor-Start, or Polyphase.
Higher overload capacities, "Mylar"* insulation, Dripproof, or totally enclosed. For horizontal or vertical installation. *Du Pont Polyester film.
HOOVER
Over 300 Hoover Agencies stand ready around the world to give your customers prompt attention.
Get full details on this offer. Write The Hoover Company, Electric Motor Division, 222 Brook Avenue, North Plainfield, N. J.

FLEXON BELLOWS *Design Briefs*

Corrosion Resistant Valve Designs Employ Flexon Bellows To Isolate Bonnet from Flow



FLEXON OFFERS THE COMPLETE BELLOWS SERVICE

Flexonics Corporation manufactures a complete range of bellows and bellows assemblies in brass, bronze or stainless steel for vacuum equipment, thermostatic devices, pressure controls, packless valves, pneumatic instruments, hydraulic mechanisms, rotating shaft seals and many other services.

The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy, today.

Good examples of how to seal a valve stem without packing are the valves illustrated. These are manufactured by the Wm. Powell Co., Cincinnati, for handling a wide range of corrosive fluids.

To isolate working parts from the flow and/or prevent contamination of the fluid being handled, Flexon Bellows are used to seal the stem opening. One end of the bellows is welded to the stem; the other end is welded to a disk that fits snugly in the gasketed female body-yoke joint.

Flexon Bellows used are stainless steel, Monel or brass depending on service. In some services the bellows must withstand pressures up to 1,000 psi, temperatures from —65° to 1500° F.

This is just one of countless seal problems that can be solved effectively with Flexon Bellows. A few of the many other uses for Flexon Bellows are given at the left. For specific recommendations, send an outline of your problem.

Flexonics *Corporation* — FLEXON BELLOWS DIVISION

1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS

—FORMERLY CHICAGO METAL HOSE CORPORATION—

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components. In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

ments, pressure ranges, pipeline fittings and element spacing is discussed. Micro Metallic Corp., 30 Sea Cliff Ave., Glen Cove, N. Y.

Circle 175, inside back cover

Gasoline Engines—Catalog 36 pp, describes line of engines ranging from 1.8 to 26.8 hp. Kohler Co., Kohler, Wis.

Circle 176, inside back cover

Heavy Duty Pumps—Catalog C, 26 pp, describes reversible pumps of 10 to 300 gpm ratings. Viking Pump Co., Cedar Falls, Iowa.

Circle 177, inside back cover

Underwriter Pumps—Catalog D, 12 pp, describes UL-approved models of 5 to 300 gpm ratings. Viking Pump Co., Cedar Falls, Iowa.

Circle 178, inside back cover

Jacketed Pumps—Catalog E, 10 pp, describes pumps designed for heating or cooling of material handled. Viking Pump Co., Cedar Falls, Iowa.

Circle 179, inside back cover

Hydraulic Pumps—Catalog 1, 8 pp, describes pumps of 5 to 200 gpm models. Viking Pump Co., Cedar Falls, Iowa.

Circle 180, inside back cover

Special Applications Pumps—Catalog J, 16 pp, describes pumps for various special purposes. Viking Pump Co., Cedar Falls, Iowa.

Circle 181, inside back cover

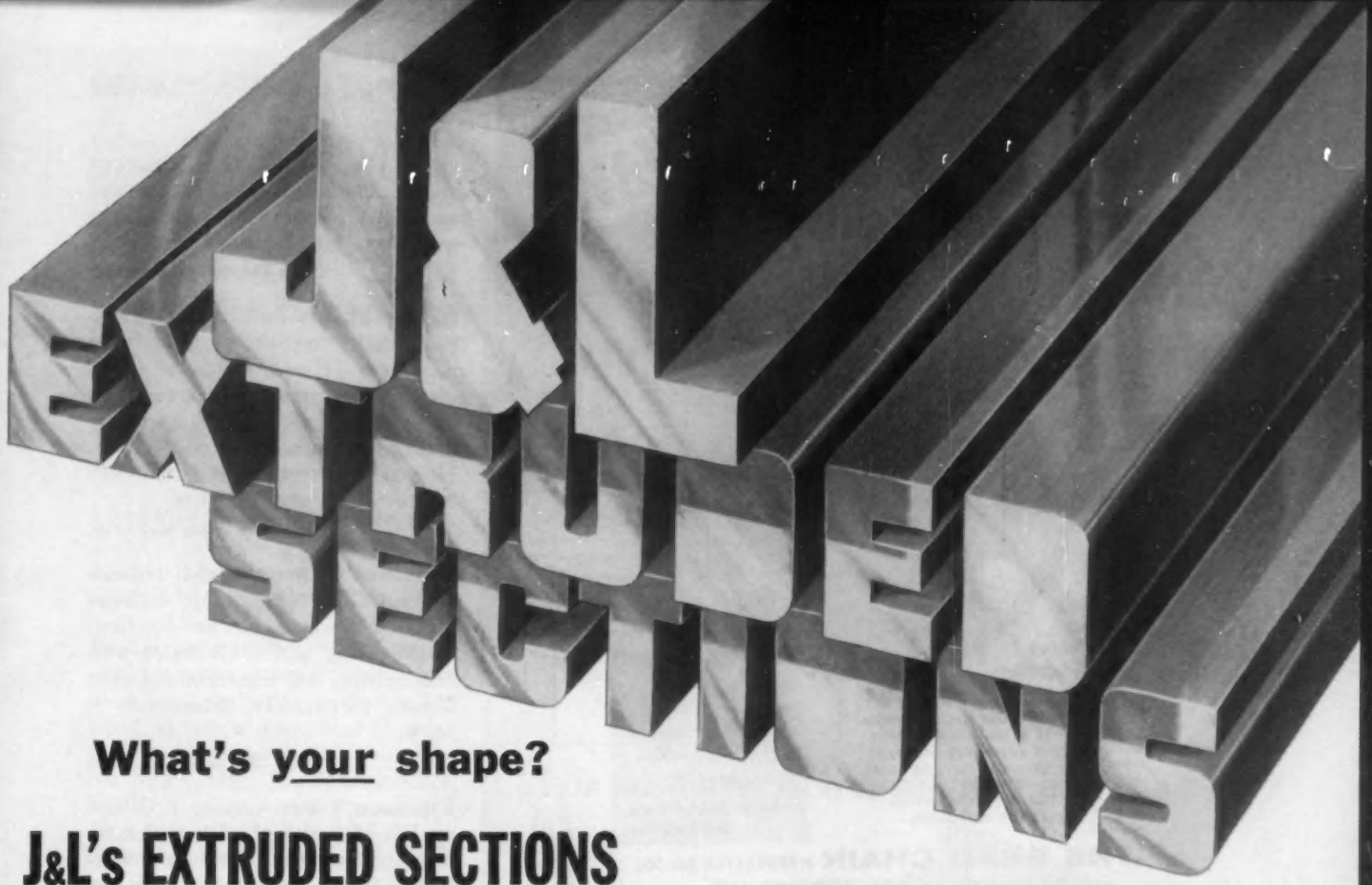
Pump Engineering Data—Catalog K, 38 pp, discusses fundamentals of rotary pump operation and application, including material on types of heads, capacity requirement, viscosity considerations, piping design, pressure factors. Viking Pump Co., Cedar Falls, Iowa.

Circle 182, inside back cover

Stainless Tubing and Pipe—Bulletin, 4 pp, describes analysis, physical characteristics and mechanical properties. Hot and cold working instructions include machining, welding, annealing, hardening and drawing. A complete size range of tubing and pipe available is also listed. Carpenter Steel Co., Union, N. J.

Circle 183, inside back cover

Solenoid-Operated Valves – Catalog D1, 50 pp, describes five basic electric



What's your shape?

J&L's EXTRUDED SECTIONS

(Hot Extruded and Cold Drawn)

can be custom-made quickly and economically

Now your complex sections can be *custom-made* at J&L's new Hot Extrusion Plant. On J&L's new equipment, they can be preformed to the predominating cross section of the part you wish to produce.

The range of sections that can be custom-made for you is almost unlimited. Quantities are extremely flexible. Production of single extrusions, where necessary, can be arranged.

In addition, J&L's Extruded Sections possess the physical benefits and accurate tolerances derived from cold drawing. And, you can obtain them in a wide range of analyses.

Send your inquiry today!

J & L EXTRUDED SECTIONS
help speed production
reduce over-all costs

J&L STEEL

Jones & Laughlin
STEEL CORPORATION — *Pittsburgh*

With J&L's Extruded Sections you can:

1. Eliminate time and costs in machining operations.
2. Eliminate time and costs in finishing operations.
3. Reduce scrap losses practically to the zero point.
4. Eliminate the cost of castings and forgings of intricate sections requiring considerable machining.

USE THIS HANDY COUPON

Jones & Laughlin Steel Corporation
3 Gateway Center, Dept. 409, Pittsburgh 30, Pa.

I am interested in knowing what your Extruded Sections can do for me.

NAME_____

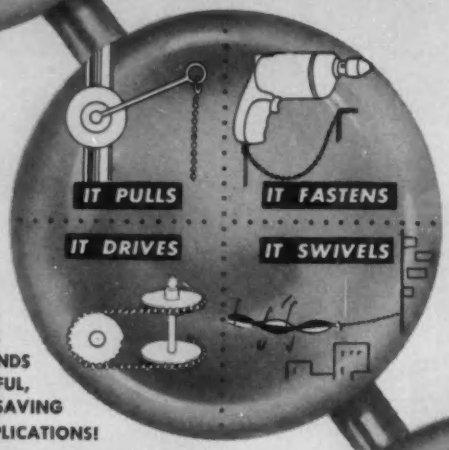
TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE_____ STATE_____

take advantage of *Versatile* **BEAD CHAIN**



IT HAS THOUSANDS OF USEFUL, COST-SAVING APPLICATIONS!

Bead Chain is available in 5 diameters from 3/32" to ¾" with tensile strengths ranging from 18 to 200 lbs., in a variety of metals and finishes. No matter what the requirement, our engineers will be glad to assist you in solving your chain applications.

For complete information send for FREE HELPFUL CATALOG

THE BEAD CHAIN MANUFACTURING CO.
92 Mountain Grove St., Bridgeport, Conn.

Stick Free CORE SHELL
multiplies mechanical operating life 5 to 6 times

A unique one-piece drawn core-shell with embossed guide points increases the mechanical operating life of the Durakool Timer-Relay five to six times, practically putting it in a "fail-safe" class. These relays are available in single or multiple units with single unit capacities of 10, 30 and 60 amperes. Time delays from 0.15 to 20 seconds—any operate-release time combination. These new 1955 relays are now in production —no extra cost.

See telephone directory for local distributor, or write.

PRE-SET TAMPER PROOF TIMER-RELAY

GUARANTEED FOR AC-DC APPLICATION and:
- No plunger sticking
- No chatter
- Quiet operation
- No double contacting

DURAKOOL, INC.
ELKHART, INDIANA, U.S.A. ••• 700 WESTON RD., TORONTO, CANADA

Durakool ALL-STEEL MERCURY *Timers*

valves, discusses possiible variations and is illustrated with photographs and charts. Skinner Chuck Co., Edgewood Ave., New Britain, Conn.

Circle 184, inside back cover

Electric Motors—Bulletin MO-3.3, 8 pp, includes complete range of frame sizes from d-c servo motors of 1⅜ in. dia to power motors of 7 in. dia. Motors with integral gear reduction are included. Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., 125 Armory St., Boston 19, Mass.

Circle 185, inside back cover

Hydraulic Constant Speed Drives—Bulletin GET-2480, 11 pp, describes operating characteristics and functions of the drives, and is illustrated with line drawings and schematic diagrams. General Electric Co., Schenectady 5, N. Y.

Circle 186, inside back cover

Expansion Valves—Catalog E 210, 6 pp, lists 14 models of valves with nominal capacity of ½ to 1¾ ton, with schematic views. Engineering data on factors important to their application is included. Controls Corp., 2450 N. 32 St., Milwaukee, Wisconsin.

Circle 187, inside back cover

Nylon Powder—Bulletin, 4 pp, gives physical and chemical properties, along with information on the various characteristics it imparts. The powder's role as a suspending agent, and the effects of filler additions, are also discussed. National Polymer Products, Inc., Reading, Pa.

Circle 188, inside back cover

Ferrous Castings—Folder 14, 4 pp, provides case histories and includes compositions of available alloys. Belle City Malleable Iron Co., Racine, Wis.

Circle 189, inside back cover

Knobs and Handles—Catalog, 12 pp, describes plastic knobs, handles, pushbuttons, dials for instruments and other products. Kurz-Kasch, Inc., Dayton 1, Ohio.

Circle 190, inside back cover

Ceilings—Brochure, 16 pp, describes and illustrates luminous, acoustical ceilings for offices, industrial areas, drafting rooms. Luminous Ceilings, Inc., 2500 W. North Ave., Chicago, Ill.

Circle 191, inside back cover

Ceramic Parts—Bulletin, 15 pp. Components of steatite, electronic glass, glass-bonded mica, Teflon, and materials for a variety of products. Centralab, 900 E. Keefe Ave., Dept. 18, Milwaukee 1, Wis.

Circle 192, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Metal Film Resistors—Brochure, 6 pp, gives full details of performance in the ½, 1, and 2 w sizes. Daven Co., 191 Central Ave., Newark 4, N. J.

Parallel Edge Scriber—Measuring device, for scribing parallel lines on all sheet stock, including synthetics, plywood, metals, is made of steel and is graduated in sixteenths, ⅛ to 1 in. Dayton Rogers Mfg. Co., Minneapolis 7, Minn.

Zinc Phosphate Coatings—Booklet, 10 pp, illustrates and explains converting of steel surfaces into complex, heavy phosphate layers chemically bound to the metal, and shows how this coating improves paint adhesion and prevents the spread of corrosion under the paint. Oakite Products, Inc., 157 Rector St., New York 6, N. Y.

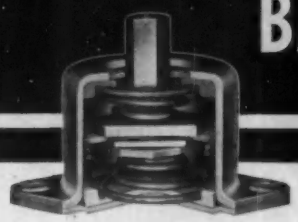
Iron Phosphate Coatings—Booklet, 12 pp, describes process by which iron phosphate coatings improve paint adherence and resist corrosion of steel. Illustrated with diagrams, drawings, and photographs. Oakite Products, Inc., 157 Rector St., New York 6, N. Y.

Multiple V-Drives—Catalog PV-200 A, contains specifications on the sizes of stock sheaves and belts, complete engineering data for design of drives, along with tables of hundreds of practical stock drive combinations already worked out. Browning Mfg. Co., Maysville, Ky.

Perforated Metals—Catalog, 114 pp, contains actual size illustrations of perforated metal samples. In addition, buying information, end uses of perforated metal, manufacturing processes are provided. Standard Stamping & Perforating Co., 3131 W. 49th Pl., Chicago 32, Ill.

NEW

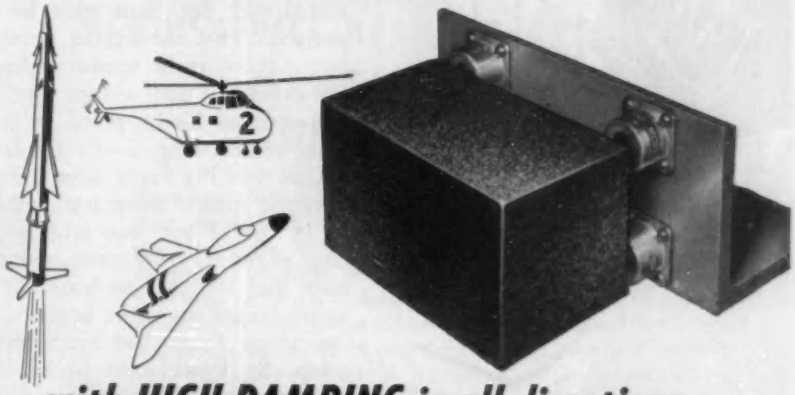
ALL-ANGL BARRY MOUNT



ALL-ANGL BARRY MOUNT
Cup diameter .....1 inch
Maximum load .....3 pounds
Weight .....less than 1 ounce

Works at any angle

...in maneuvers through every position

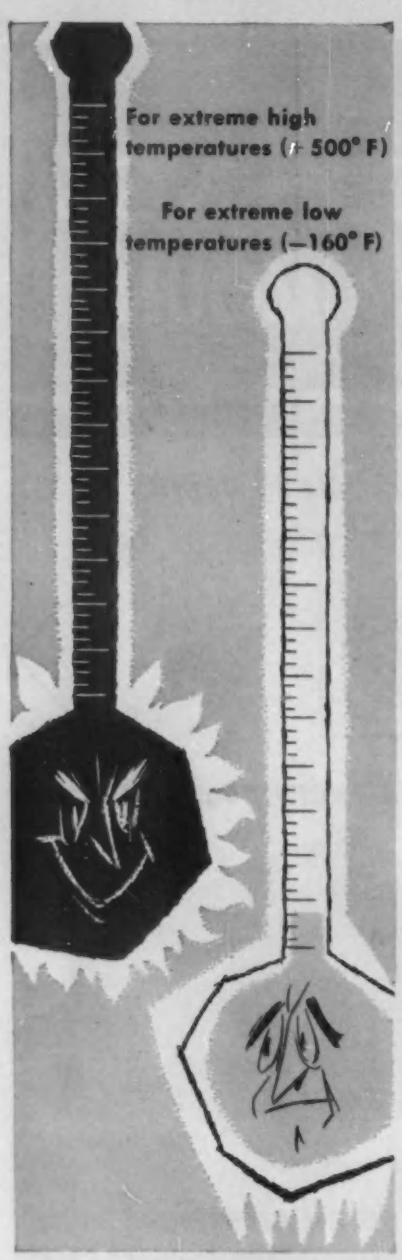


...with HIGH DAMPING in all directions

Now you can forget all limitations on mounting positions for delicate apparatus. You can design for easiest installation and best space utilization, because the new Barry ALL-ANGL vibration isolator works in any position. Upside down, on a bulkhead, at any slant—position means nothing to this new BARRYMOUNT.® Damping is exceptionally high in all directions; transmissibility at resonance is less than 3. The ALL-ANGL mount is interchangeable with other miniature BARRYMOUNT isolators.

This isolator is the answer to your toughest vibration-protection problems. Let us show you what it will do for you. Write for Bulletin.

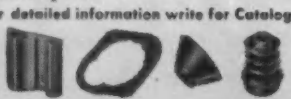
BARRY CONTROLS
INCORPORATED
Formerly The Barry Corporation
730 PLEASANT STREET • WATERTOWN 72, MASS.
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES



SPECIFY STALWART
Silicone Rubber Parts

For Silicone rubber parts that give maximum performance at searing temperatures up to +500° F... retain their elasticity down to —160° F... or have the physical, chemical and dielectric properties to resist chemicals... it will pay you to see STALWART first! From stocks compounded for specific job requirements, STALWART will mold, extrude, die-cut, lathe-cut, or mandrel-build parts to meet individual, S. A. E. or A. S. T. M. specifications. Bring your rubber problems to STALWART... specialists in the custom-fabrication of precision Silicone parts.

For detailed information write for Catalog 51SR-1



6307-SR

STALWART RUBBER CO.

Mfg. Plants in Bedford, Ohio and Jasper, Georgia
Main Offices 166 Northfield Road, Bedford, Ohio

Ad Libbing by the Editor

Big Frank never planned little things. He always set his sights for maximum range plus another long stretch. That is why he frequently had to lower his sights and be discontented with less than what he had planned. That is why Big Frank always seemed to be terribly unhappy. But actually it only seemed that way. He expressed his happiness by grumbling or bellowing, mostly the latter.

One time Big Frank faced a job of screening cracked stone, tons and tons of it. Big Frank was told by the chief engineer of the screen manufacturer that 100 tons an hour was the maximum output of the largest screen for which Frank had space in his setup. So Frank went to his chief engineer and told him to design a screening plant layout that would screen 200 tons an hour, using that same screen. Knowing his boss quite well, the engineer Joe, immediately concluded that Big Frank had been told that 100 tons an hour was the most that could be gotten out of that size of screen.

When Big Frank's engineer studied the problem he found out that the 100 tons an hour rating was based on 90 odd per cent screening efficiency, as is usually required in processing operations. The job on hand required that "everything" less than ½ in. size had to be screened out and that efficiency was of no importance. So Joe, the engineer, simply specified a three-quarter inch square mesh screen. It worked beautifully and more than 200 tons an hour passed over and through the screen.

Big Frank beamed. Again it was proven to him that all he needed to do was to bellow loudly enough and he got what he wanted.

Some years later, Big Frank needed a new clutch on his drive, so Chief Engineer Joe wrote down the specs and Big Frank went to the screen manufacturer who also made the clutches. But it just happened that the manufacturer had redesigned the whole line of clutches and hence the desired clutch had a different model number. The sales manager explained this to Big Frank but he just couldn't or wouldn't understand. As a last resort the sales manager took Frank into his company's chief engineer's office. An argument followed.

When the company chief engineer tried to explain the situation, Big Frank repeatedly came back with the statement that his engineer, Joe, had specified the other model. Finally the chief engineer started to explain that, "Big Frank, your chief engineer doesn't know that we have redesigned the line of clutches." He only got as far as "your engineer doesn't know," when Big Frank figuratively blew up.

"What do you mean Joe doesn't know. He knows more about your stuff than you know yourself. Didn't you tell me your screen couldn't do more than 100 tons. Didn't Joe make it do better than 200 tons. What do you mean that Joe don't know?"

When Webster, the sales manager, told me about the incident he said his chief engineer was stunned speechless. It took real diplomacy on Webster's part to avoid a brawl. G.F.N.

FOUR *REALLY TOUGH* MUELLER BRASS CO. REFRACTORY BRONZE ALLOYS IN ROD FORM

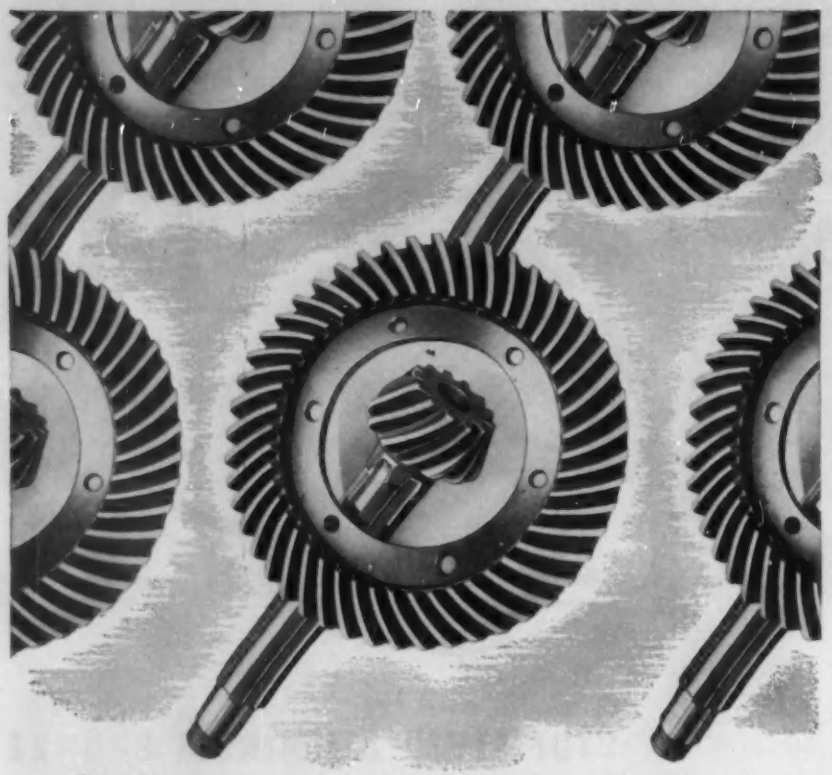
"TUF-STUF" ALUMINUM BRONZE
"600" SERIES BEARING BRONZE
MANGANESE BRONZE
ALUMINUM SILICON BRONZE

These four Mueller Brass Co. alloys have been specifically formulated to meet the demands of applications where manufactured parts must stand up under the most adverse operating conditions. While these alloys are tough, they are relatively easy to machine. Parts made from these alloys are in dependable daily service and range from marine hardware to valve guides in aircraft engines. As specialists in brass and bronze alloys, the Mueller Brass Co. can offer you the exact alloy best suited to meet the requirements of any application problem. Write us today for details.

NAME OF ALLOY	ALLOY NO.	YIELD STRENGTH AT 0.5% EXTENSION LBS./SQ. IN.	TENSILE STRENGTH LBS./SQ. IN.	ELONGATION % IN 2 IN.	BRINELL HARDNESS	RELATIVE MACHINABILITY —FREE CUTTING BRASS = 100%	ALLOY CHARACTERISTICS
TUF-STUF ALUMINUM BRONZE	224-E	60,000	90,000	15	175	30	Resists oxidation and retains strength at elevated temperatures. Lightweight. Used in aviation industry.
TUF-STUF ALUMINUM BRONZE	224-C	62,000	95,000	9	185	35	Properties generally higher than 224-E. Non-Galling. Acid and corrosion resistant.
MANGANESE BRONZE—A	241-A	55,000	78,000	20	150	25	High torque resistance. Tough. For screw machine parts and forgings — valve stems, balls, airplane parts.
MANGANESE BRONZE (HIGH TENSILE—GRADE B)	721	68,000	115,000	10	200	35	Highest strength of the copper base alloys. Good shock and wear resistant properties. Used for rollers, rotors, valve stems.
FORGEABLE BEARING BRONZE	600	40,000	78,000	15	165	25	For use where excessive pounding action encountered. Excellent bearing properties. For bushings, gears, marine hardware, etc.
FORGEABLE BEARING BRONZE	602	40,000	74,000	12	150	65	Used with hard or soft mating members that do not have a high polish. Modification of 600 alloy—for use where difficult machining is necessary.
ALUMINUM SILICON BRONZE	802	45,000	90,000	15	175	65	Excellent machinability for high strength bronze. Corrosion resistant. For pole line hardware. Non-magnetic.

MUELLER BRASS CO. PORT HURON 17, MICHIGAN

149



Over and over again...

FAIRFIELD

SAVES YOU MORE ON TOP-QUALITY GEARS

Fine Gears Made to Order
for all manner of industrial equipment

SPIRAL BEVEL
STRAIGHT BEVEL
HYPOID
HERRINGBONE
HELICAL
DIFFERENTIALS
SPUR
WORMS AND WORM GEARS

• *Send for your copy of illustrated bulletin describing Fairfield's facilities for making gears.*

Fairfield is famous for repeat orders — and simply because quality is consistently high, and price is—well, just try to beat it!

How can Fairfield manage this unique position year after year? Truth is, it involves some tried-and-true mass-production methods plus some very special Fairfield ideas developed in the past 35 years of precision gear making.

Then, of course, Fairfield is ideally located with all facilities *under one roof.* Here you will find a complete metallurgical department, batteries of the most modern machines, testing laboratories, latest heat-treating equipment—all operated by skilled craftsmen working under expert engineering supervision.

There's another Fairfield service worth looking into—the expert recommendations on your particular gear problems. Your inquiry will receive prompt attention.

FAIRFIELD MANUFACTURING CO. For FINE GEARS

2305 SOUTH CONCORD ROAD • LAFAYETTE, INDIANA

ENGINEERING ABSTRACTS

Considerations in the Design of Structural Models

Abstracted from "Considerations in the Design of Structural Models," by Coleman Raphael, Republic Aviation Corp., *Aeronautical Engineering Review,* February 1955.

A structural model is one that, although not necessarily geometrically similar to its prototype, will faithfully reproduce, to some predetermined scale, the required structural characteristics. These may be stresses, strains, deflections, buckling loads, and/or some combination thereof. The primary purpose of such a model is that it can generally be built with considerable simplification and at lower cost.

Ideal structural characteristics could be obtained from a model that is a geometric duplication of its prototype, in which all dimensions, fastenings, tolerances have been reduced (or enlarged) to the same scale. While this will yield the most exact results, inherent fabrication difficulties generally negate its value. Since no machined contours are eliminated, and the sizes of fasteners, holes and tolerances become nonstandard, it is almost always easier and quicker to build the prototype than its model. In addition, if the model is to be in a much smaller scale, it becomes increasingly difficult to maintain geometric detail similarity.

It is therefore good practice to design the model for structural characteristics alone, using the prototype detail dimensions only to serve as a guide.

For structural similarity, with a scale factor, N_l, applying to longitudinal and transverse lengths:

Type I:

$$A_m = \frac{E_p A_p}{E_m N_f} \; ; I_m = \frac{E_p I_p}{E_m N_f N_l^2} \; ; \qquad (1)$$

$$J_m = \frac{G_p J_p}{G_m N_f N_l^2}$$

For close approximation to geometric similarity:

Type II:

$$A_m = \frac{E_p A_p}{E_m N_l^2} \; ; I_m = \frac{E_p I_p}{E_m N_l^4} \; ; \qquad (2)$$

$$J_m = \frac{G_p J_p}{G_m N_l^4}$$

and, if prototype and model material are the same:

Type III:

$$A_m = \frac{A_p}{N_l^2} \; ; I_m = \frac{I_p}{N_l^4} \; ; J_m = \frac{J_p}{N_l^4} \quad (3)$$

The following relationships follow immediately from the foregoing design equations:

Bending Deflections:

$$\frac{\Delta_m}{\Delta_p} = \frac{\frac{KP_mL_m^3}{E_mI_m}}{\frac{KP_pL_p^3}{E_pI_p}} = \frac{P_m}{P_p}\left(\frac{L_m}{L_p}\right)^3\left(\frac{E_p}{E_m}\right)\frac{I_p}{I_m} \quad (4)$$

$$= \frac{1}{N_f}\,\frac{1}{N_l^3}\,\frac{E_p}{E_m}\left(\frac{E_m}{E_p}\right)N_fN_l^2 = \frac{1}{N_l}$$

Torsional Angular Deflections:

$$\frac{\theta_m}{\theta_p} = \frac{K\frac{(P_mL_m)\,L_m}{G_mJ_m}}{K\frac{(P_pL_p)\,L_p}{G_pJ_p}} \quad (5)$$

$$= \frac{P_m}{P_p}\left(\frac{L_m}{L_p}\right)^2\frac{G_p}{G_m}\,\frac{J_p}{J_m}$$

$$= \frac{1}{N_f}\,\frac{1}{N_l^2}\,\frac{G_p}{G_m}\left(\frac{G_m}{G_p}\,N_fN_l^2\right) = 1$$

Equations (4) and (5) apply to structural models of all three types.

Bending and Twist Moments

Types I:

$$M_m/M_p = P_mL_m/P_pL_p = 1/N_fN_l \quad (6)$$

Types II and III:

$$M_m/M_p = 1/N_fN_l = 1/N_l^2 \quad (6a)$$

Axial Stresses

Type I:

$$\frac{S_m}{S_p} = \frac{\frac{P_m}{A_m}}{\frac{P_p}{A_p}} = \frac{P_mA_p}{P_pA_m} \quad (7)$$

$$= \frac{1}{N_f}\,N_l^2 = \frac{N_l^2}{N_f}$$

Types II and III:

$$S_m/S_p = 1 \quad (7a)$$

Bending Stresses

$$\frac{S_m}{S_p} = \frac{\frac{M_mc_m}{I_m}}{\frac{M_pc_p}{I_p}} = \frac{M_m}{M_p}\,\frac{c_m}{c_p}\,\frac{I_p}{I_m}$$

Types I and II:

$$\frac{S_m}{S_p} = \frac{1}{N_fN_l}\,\frac{c_m}{c_p}\left(\frac{E_m}{E_p}\,N_fN_l^2\right) \quad (8)$$

$$= N_l\,\frac{c_m}{c_p}\,\frac{E_m}{E_p}$$

Type III:

$$S_m/S_p = N_l\,(c_m/c_p) \quad (8a)$$

If the model has been designed so

Mr. L. M. Puster of our engineering staff, specialist in bellows applications.

● Whatever your problems on bellows assemblies, this specialist can give you answers that will save you time, trouble and money.

He'll know the advantages of metals to be considered for your application—brass, stainless steel, monel or nickel. He'll know the type of end fittings you should use. He'll recommend the correct bellows charge—volatile liquid or gas. And he'll give you the right advice on many other factors that will help make your bellows design plans more efficient.

Sylphon and Bridgeport bellows assemblies are used in many ways—for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints, as flexible connectors and in more applications.

Find out how our engineers can help you—and count up the savings our half-century of experience and ample production facilities can make for you. Write for full information.

SEND FOR FREE BULLETIN

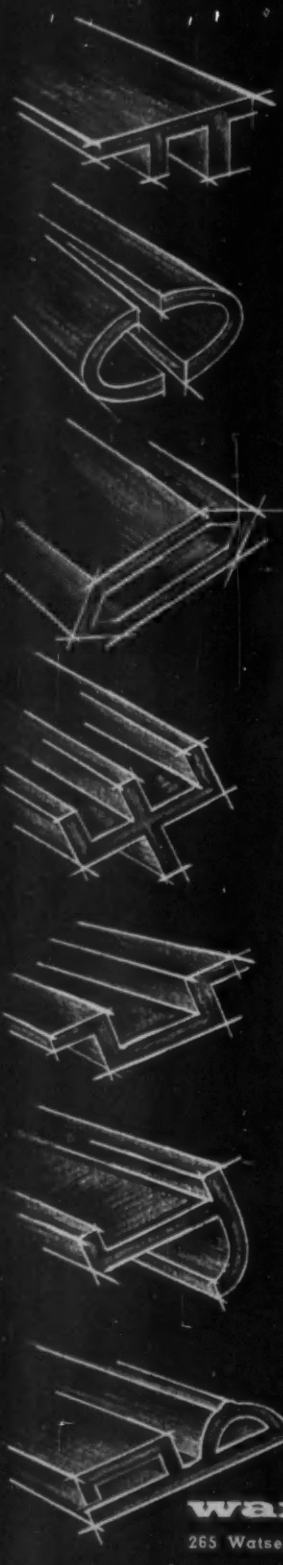
An idea-filled bulletin about metal bellows and bellows assemblies is yours for the asking. Send for free copy. Ask for Catalog JP-1400.

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION KNOXVILLE 1, TENNESSEE

BRIDGEPORT THERMOSTAT DIVISION BRIDGEPORT 1, CONNECTICUT

FACILITIES — KNOW-HOW — IMAGINATIVE ENGINEERING



THE SHAPES OF THINGS TO COME

ALUMINUM EXTRUSIONS made for you by WARNER

If your product or project — or their components — are adaptable to aluminum extrusions, you will be able to:

- REDUCE COSTS
- ELIMINATE MATERIAL REMOVAL
- PROVIDE EASIER WORKABILITY
- GAIN GREAT STRUCTURAL STRENGTH
- REDUCE WEIGHT
- ADD CONSUMER APPEAL

Call now for an enlightening conference with Warner engineers. Without cost or obligation you may learn how you can gain more at lower cost while improving your product and its saleability. Complete services from creative planning through finished extrusion.

warner mfg. corp.
265 Watsessing Avenue Bloomfield, New Jersey

Canadian Office: 224 Boulevard Labelle, St. Rose, P.Q

that heights as well as lengths are reproduced to the scale factor N_l, then $N_l\ (c_m/c_p)$ will be equal to 1 and the stresses in the Type III model will be duplicated.

Torsional Shear Flow (Thin-Walled Cellular Structures)

Type I:

$$\frac{Q_m}{Q_p} = \frac{\dfrac{T_m}{2A_m}}{\dfrac{T_p}{2A_p}} = \frac{T_m}{T_p}\,\frac{A_p}{A_m} = \frac{1}{N_f N_l}\,\frac{A_p}{A_m} \qquad (9)$$

Types II and III:

$$Q_m/Q_p = (1/N_l^2)\ (A_p/A_m) \qquad (9a)$$

If the model has been designed so that cellular enclosed areas have been reproduced to the scale factor N_l^2 (a natural consequence of duplicating heights, as well as lengths), then for all three types of models

$$Q_m/Q_p = 1/N_l \qquad (9b)$$

In a similar fashion, it is evident that the relationship between any physical quantities can be determined in terms of the basic dimensional parameters.

Symbols

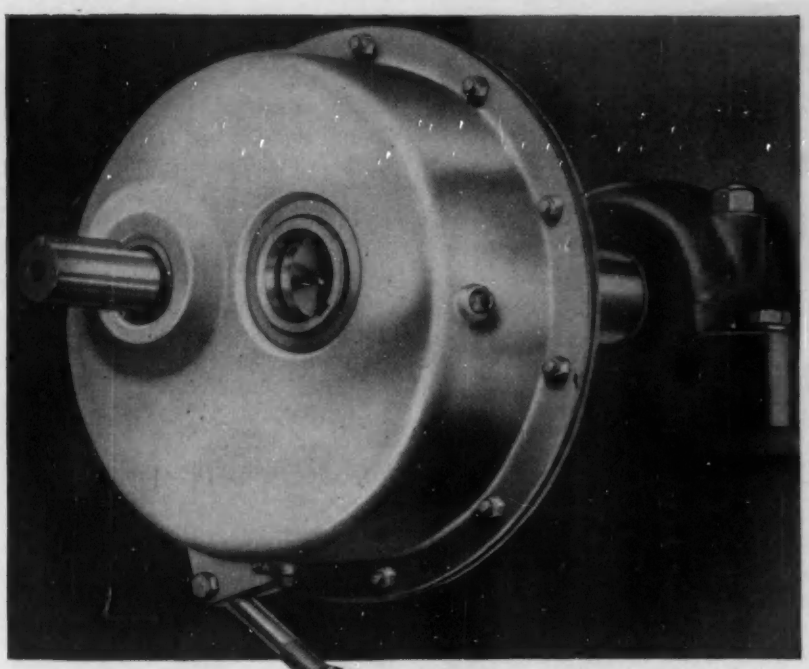
A = area, sq in.
c = distance from bending axis to extreme fiber, in.
E = modulus of elasticity, lb per sq in.
G = modulus of rigidity, lb per sq in.
I = rectangular moment of inertia, in.^{4}
J = polar moment of inertia, in.^{4}
k = spring constant of supports
K = any constant
M = bending moment, in-lb
N_l = prototype lengths/model lengths
N_f = prototype forces/model forces
P = load, lb
Q = shear flow, lb per in.
s = stress, lb per sq in.
T = torque, in-lb
Δ = linear deformation or deflection, in.
θ = angular deformation or deflection, rad.

Subscripts
p = prototype
m = model

Papers on Automatic Literature Searching

Abstracted from "Searching The Literature Automatically" which appeared in the December, 1954, issue of *Metal Progress*.

Battelle Memorial Institute, working with manufacturers of automatic electronic machines, is developing systems for analyzing, coding and searching literature. Machinery is about to be delivered for work on "Review of Metal Literature" as trial-run on metallurgical literature. To sustain esti-



SIX SIZES

- 1/2 to 30 hp
- Single or double reduction
- Wide output speed range—420 to 10 rpm

FALK

ALL-STEEL

Shaft Mounted Drives—

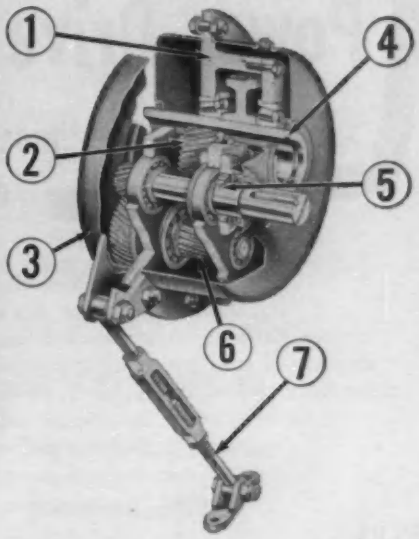
simple-compact-rugged-efficient

Created specifically for the vast number of applications demanding a sturdy and compact speed-reducing unit for direct mounting on the driven shaft, the new Falk all-steel Shaft Mounted Drive is built to give long service life at substantial savings of space, time, power and maintenance costs!

This efficient helical-gear drive, latest in the unmatched list of Falk precision-gearing achievements is an ingenious modification of the time-tested Falk Motoreducer design which has held, for more than 20 years, recognized leadership in this branch of highest-quality power transmission . . . It complements and completes the world-famous Falk line of reduction units covering the entire range of industrial applications.

Investigate the Falk all-steel Shaft Mounted Drive. Write to Department 247 for engineering bulletin, including selection and dimension details.

These famous FALK "In-built" factors *mean long life and dependability...*



1 **All-steel Frame,** with more than double the rigidity of iron, supports all rotating elements.

2 **Precision Helical Gears,** designed and machined by Falk, rated to AGMA standards.

3 **Pressed Steel Housings,** whose sole function is to keep oil in, dirt out; easily removed for gear inspection without dismounting unit.

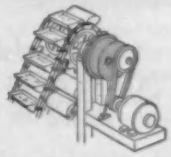
4 **Through Hollow Shaft** with counter bore provides for easiest installation or removal from driven machine shaft extensions.

5 **Backstop** can be furnished with the unit or added later for positive prevention of reverse rotation.

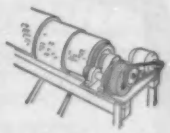
6 **Positive Lubrication,** continuous direct dip of revolving elements at all speeds.

7 **Tie Rod** and turnbuckle serve as anchor and facilitate V-belt or chain adjustment.

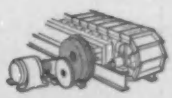
A FEW TYPICAL APPLICATIONS



BUCKET ELEVATOR



SAND CLASSIFIER



APRON FEEDER

BELT CONVEYOR

THE FALK CORPORATION, Milwaukee 8, Wisconsin

MANUFACTURERS OF

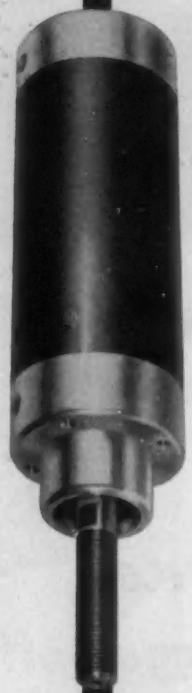
- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

. . . a good name in industry

NEW NP Power Drive Cylinder

. . . has all the "most wanted" design features



No other cylinder offers you so many vital features: compact, streamlined design; lightweight aluminum alloy and steel construction exceeds all strength requirements; interchangeable mountings — foot, flange, pivot, clevis and trunnion. Every cylinder can *operate with air, water or oil without interchanging or adding parts:* Adjustable cushioning (optional) can be added to any cylinder at any time.

PLUS

1. Sealed-in lubrication eliminates line lubricators.
2. Rod wiper and long, self-lubricating bronze rod bearing.
3. Self-compensating synthetic multiple "V" rod packing.
4. Rod packing and bearing externally removable.
5. Large porting gives quick response and smooth performance.
6. Rotatable end caps allow 360° piping location.
7. Rust-proofed cylinder tubing has tough I.D. surface.
8. Bronze piston bearing assures maximum support.
9. Ground and polished stainless steel piston rod.
10. Synthetic "U" cups automatically adjust for wear.

Mail this coupon for data sheets

INDUSTRIAL ACTUATORS AND CONTROLS DIVISION,
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN: Please send me complete information on

☐ NP Power Drive Cylinder ☐ NP Power Check feed control
☐ NP Power Trol valves

*Name*_____ *Title*_____

*Company*_____

*Street*_____

*City*_____ *Zone*____ *State*_____

NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

125 Amory St., Boston 19, Mass.
Sales Service Representatives in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

mated trial-run cost of $15,000 a year for 15 years, aid must come from industry, research institutes and educational foundations. Solution of metallurgical literature problem will help solve literature problems of all branches of knowledge. Lines of utility seen include 1) Large companies could own duplicates of all or any part of machine record supplemented by company's private information; 2) literature searches could be made by central depository; 3) small companies could be furnished cards written in plain English on a given specialty.

Abstracted from a Special Report on "Special Classifications" prepared for the SLA Committee by Allen Kent, Principal Documentation Engineer, Battelle Memorial Institute, Columbus, Ohio, which appeared in the December 1954 issue of *Special Libraries.*

The SLA Committee on Special Classifications has been studying machine literature-searching methods under development at Battelle Memorial Institute. Comparison has been effected between the ASM-SLA Metallurgical Literature Classification and the developing Battelle system. Terminology used to characterize aspects of metallurgical literature was investigated; methods to incorporate new terms in the Battelle code-dictionary were conceived. Description given card-file system to form basis of a semantic code dictionary.

Abstracted from "Machine Functioning and Organization of Semantic Units" by F. U. Luehrs, Jr., Allen Kent, J. W. Perry and M. M. Berry, of Battelle Memorial Institute which appears in *American Documentation,* 1955, Vol. VI, No. 1.

Basic principles that control the design of code system for expressing the analysis of documents in a manner suitable for machine searching. Symbols and relationships used in code designations; how effective discriminating power may be achieved in a machine-searching system.

Engineering Communications

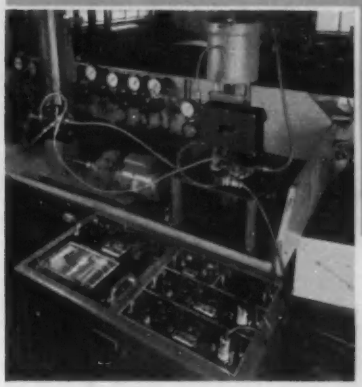
Abstracted from "Engineering Communications — What's Wrong? — Too Many Change Orders Skyrocket Costs.," by Capt. R. E. W. Harrison, U. S. Naval Reserve; *Journal of the American Society of Naval Engineers, Inc.,* Feb., 1955.

Evolution of a newly designed piece of machinery usually follows a well-estab-

At the Mass. Institute of Technology Machine Tool Laboratory the effect of variables such as cutting fluid, tool geometry, speed and feeds, and tool material are measured and recorded, using a dynamometer and Sanborn two-channel System. Such records for various lathe operations, as well as many other cutting operations, provide valuable insight into the whole metal cutting process.

. . . from lathe cutting forces to telemetered aircraft data . . .

SANBORN Oscillographic RECORDING SYSTEMS prove their versatility



At Moore Products input and response of their Valve Positioner, a pneumatic instrument widely used on diaphragm top-work valves and power cylinders, are recorded on a Sanborn two-channel System. Impulses from a pneumatic sine wave generator, of frequencies as high as 20 cps, are fed through a transducer to one channel, with valve stem response recorded by the second channel from a strain gage pickup.

At Edwards Air Force Base, California, this U. S. Air Force telemetering van received and recorded information transmitted from various pickups and transducers in the new delta wing Convair YF-102A during flight. Photos of van interior show eight Sanborn four-channel recording systems in rear, and close-up of four of the systems. Thus equipped, the van could receive data which would affect the design and performance of the YF-102A, a faster-than-sound, all-weather interceptor built by the Convair Division of General Dynamics Corporation.

These typical two- to 32-channel applications of Sanborn oscillographic recording systems give an indication of the tremendous scope of this versatile equipment. Elsewhere, Sanborn 1-, 2-, 4-, 6- and 8-channel systems and components are used in meteorological research . . . quality control programs . . . instrument and machinery field testing.

Flexibility of Sanborn design permits interchangeable amplifiers and preamplifiers to meet *individual* recording requirements with greater over-all efficiency and economy. Other Sanborn features include *inkless* recording in true rectangular coordinates, high torque galvanometer movement, time and code marking, and numerous chart speeds.

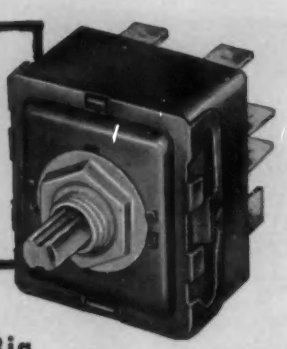
CATALOG AND TECHNICAL DATA AVAILABLE ON REQUEST

SANBORN COMPANY

INDUSTRIAL DIVISION
CAMBRIDGE 39, MASS.

This Little Switch Goes to Market

. . . in air conditioners, fans, unit heaters, appliances, motor and resistive circuits.



This Little Switch Is Big

Ratings range up to 25 A. at 120 or 240 V., and ½, ¾ and 1 hp at 120 V. and 2 hp at 240 V., A.C. U.L. Approved. (Small D.C. ratings also available.) *But base is only* 1½" x 1¼" x ⅞".

This Little Switch Saves Money

Costs less—permits simplification of your designs. Spindle extensible through base to permit ganging of mechanical and electrical controls . . . spade terminals for quick wiring . . . dummy terminals, if required, to eliminate need for blocks.

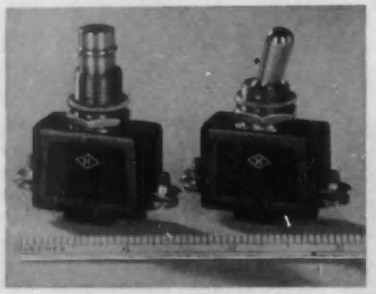
This Little Switch Is The NEW "Diamond H" Series 390 Rotary

. . . single or double pole, two to twelve positions with stop as required. Single, two-hole or special mounting arrangements. Completely interchangeable with the widely used "Diamond H" Series 240 switches which are still available.

Write today for complete information to meet your requirements

THE HART MANUFACTURING COMPANY

206 BARTHOLOMEW AVE., HARTFORD, CONN.



Switches for products you are proud of

SERIES 1400

TOGGLE AND PUSH BUTTON

Designed for products demanding a combination of high capacity, small size and long life, Diamond H Series 1400 switches pack UL approved ratings up to 25 A. and 2 H.P. at 240 V., A.C., into bases measuring only 61/64" x 21/32" x 1-3/16".

Spring-loaded roller keeps pressure on contact mechanism in all positions to provide smooth and unfailing action in such applications as portable tools, panelboards, home workshop power tools, light industrial machines, vacuum cleaners, power amplifiers and similar products.

Toggle switches available single pole, single throw (dummy terminals optional) and single pole, double throw (two and three position and momentary, one or both sides). Push button switches are single pole, off and on, and momentary double throw, no off. All standard ratings to 1-1/2 H.P. at 120 V., 2 H.P. at 240 V., and to 25 amperes at 120 and 240 V., A.C. only. Special ratings to 30 amperes at 120 V., A.C. and special D.C. ratings also available.

Write for Bulletin B6

THE HART MANUFACTURING COMPANY

206 BARTHOLOMEW AVENUE, HARTFORD, CONN.

lished pattern of ten major steps which include functional concept specification, through engineering design specification, working drawings for foundry, forge, machine shop, erection, test and evaluation in the field.

Not infrequently the functional concept is the brain child of a brilliant strategist in the particular field under attack—but a strategist who knows little or nothing about the available techniques whereby his concept must be translated into actuality. It is this author's plea that a competent engineering opinion be conveniently placed, when the strategist feels a good concept is about to be born.

Time spent at this stage of the game in really searching for precept and example will be repaid many times over. Well-stocked libraries, information index services, eager trade magazine publishers and accessory manufacturers can all prove wells of valuable information tailored to avoid repetition of previous failures.

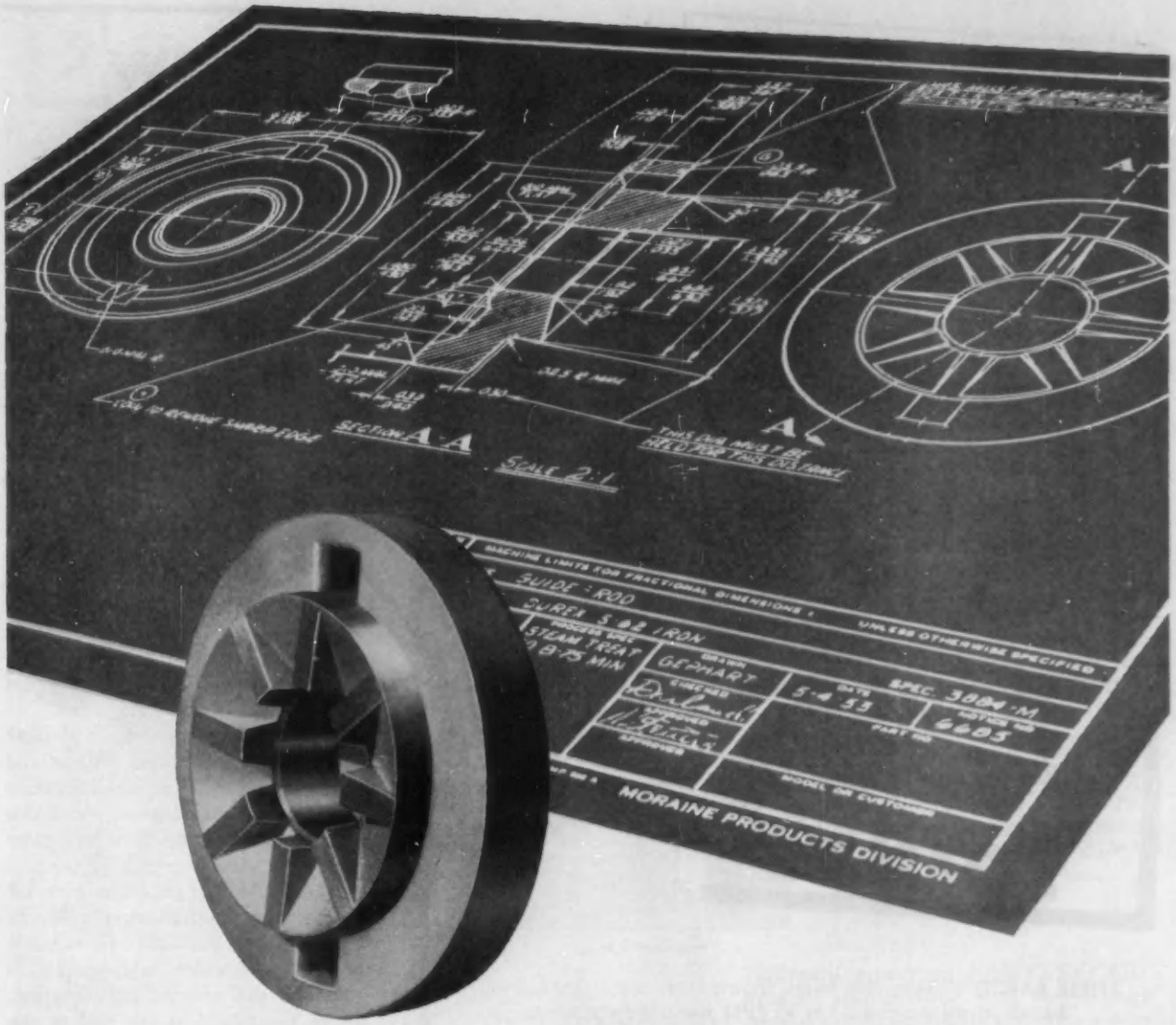
At this point, extremely sound judgment is required from the directing head of the engineering department. There must exist the virtue of simplicity, the most economical use of materials and man hours, plus the maximum use and reference of existing proved standards applied as subassembly units or components.

The next stage is the first real translation of words into drawings. A skillful and experienced designer, after studying his specifications, can quickly detect the major areas holding design problems. Communication between experienced field operators and the designer making the exploratory layouts is a must.

Before firming up exploratory layouts, it is of prime importance that the heads of fabricating and test departments be brought in to contribute their quota of experience.

The ten progressive steps outlined are recommended as an effective antidote to the prevailing practice of issuing a multitude of change orders.

The basic problem to be solved is one of engineering management, and this, to be sound, must have its foundations firmly entrenched in accurate scheduling and by better two-way communications up and down the line from the time when that genius, with the new concept of performance, decided that his brain child merits a chance to prove itself worthy.



MORAINE MAKES MANY COMPLEX PARTS FROM METAL POWDER

When you examine the background print you note the intricate design and close tolerances demanded of this metal powder part. Imagine the expense entailed in producing this part by conventional casting and machining methods!

Through the use of Moraine metal powder technique, this part is produced to precision standards with *one* press operation. The savings in cost make a most important contribution to the over-all profit possibilities of products using similar parts.

This is but one more example of what is being accomplished through cooperative effort between customer and Moraine. Industries everywhere are improving performance and cutting costs by sharing Moraine's experience with metal powder.

moraine products
DIVISION OF GENERAL MOTORS, DAYTON, OHIO

METAL POWDER PARTS

A SERVICE REPORT—

"On Job 4 Years ...No Repairs!"

BARCO *Revolving* JOINTS

Installation: American Viscose Corporation, Marcus Hook, Pa.

THESE BARCO 1" Type IBR Joints, shown in the above photograph, handle 45 psi steam at 20 to 30 RPM and run up to 8 hours per day. Their unusual record of four years service without repairs shows that, Barco Rotary Steam Joints are your best insurance for long, trouble-free service.

HOW MUCH does it cost to use less efficient types of rotary joints? . . . For Repair Part? . . . For "Down Time"? . . . For Extra Power Costs? CHECK THE FACTS—then look at these Barco advantages:

- **Trouble-free Performance! Thanks to long lasting "CTR" V-Type Seal Rings—a Barco Development.**
- **Low Maintenance; No Adjusting. Easy to inspect or service, with no special tools required.**
- **Low Torque—Cuts Power Costs up to 50%.**
- **Unexcelled Ability to withstand Vibration and Hard Usage.**
- **Better Temperature Control where steam is used for heating rolls due to better circulation. Barco Joints hold seal standing or running.**

YOU CAN PROVE IT IN YOUR OWN MACHINERY—make this test now with new, improved Barco Revolving Joints. Send for complete information and a copy of Catalog No. 300B. BARCO MANUFACTURING CO., 527F Hough St., Barrington, Ill.

BARCO

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING, AND REVOLVING JOINTS

NEW BOOKS

Metallurgy Of The Non-Ferrous Metals

W. H. DENNIS, B.Sc. (Lond.), A.M. I.M.M., *Metallurgical Engineer*, 5½ x 9 in., 647 pp. *Published by Pitman Publishing Corp.*, 2 W. 45 St., New York 19, N. Y. $12.50.

The reviewer finds this book to be one of the most complete of its kind. All of the non-ferrous metals are included. Each chapter deals with a specific metal and information as to occurrence, extraction, refining and alloying is included. Properties of the alloys are given along with other data which is important to the metallurgical student and practitioner.

The text does not include obsolete methods of extraction. While the book was written by an English author and published in England, American metallurgical practices have been given prominence in the text.

The 22 chapters are quite short but there is enough information in each to warrant use of the book as a valuable reference. A short bibiliography is given at the end of each chapter. Three appendices at the end of the text round out the book.

The Light Metals Handbook

GEORGE A. PAGONIS, *Light Metals Research Laboratory, San Jose, Calif.*, 6½ x 9 in., *Volume I—Text*, 199 pp.; *Volume II—Tables*, 185 pp. *Published by D. Van Nostrand Co., Inc.*, 250 *Fourth Ave., New York 3, N. Y.* $8.50.

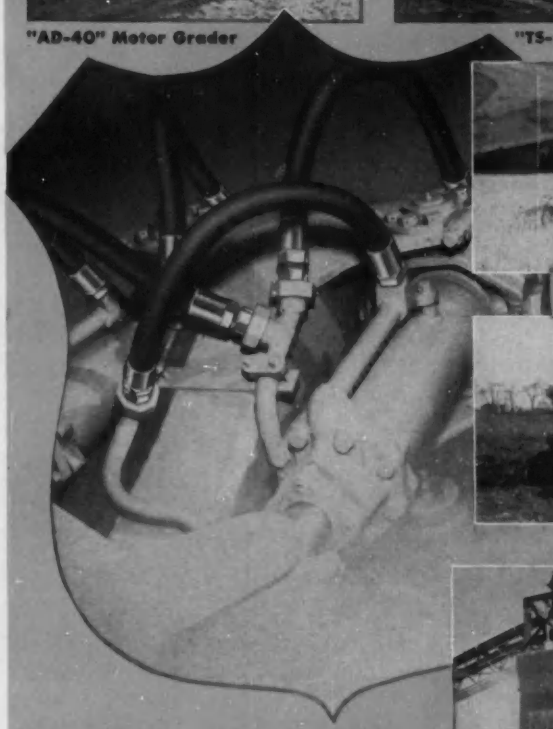
This book falls short of its objective. Any handbook on light metals should include titanium and lithium. No mention is made of these two important metals in this book.

The book is divided into two volumes bound together. Volume I covers the text and Volume II contains all of the tables to which reference is made in Volume I. They are bound together so that they may be separated easily. Neither of the two volumes is indexed. The language of the book

Eastman HYDRAULIC HOSE ASSEMBLIES DELIVER MOBILE POWER *for* ALLIS-CHALMERS

"AD-40" Motor Grader

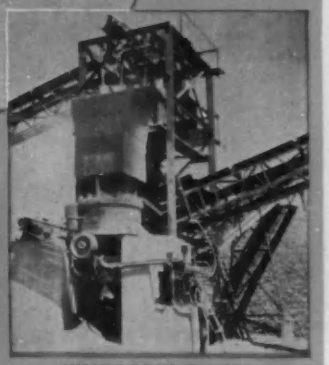
"TS-300" Motor Scraper



Eastman Hydraulic Hose Assemblies used on steering ram of Allis-Chalmers TS-300 and TS-360 Motor Scraper. Also used on TS-200 Series to control steering, plus apron, ejector and bowl action—applying down pressure when loading equal to the weight of the scraper—38,560 lbs.!

ALL-CROP Harvester

"WD-45" Tractor



HYDROCONE Crusher

GLACIERS NEVER HAD IT SO EASY . . .

The millions of years required by the glaciers to scour and alter the earth diminish to mere minutes when Allis-Chalmers earth moving and grading machinery go to work. Many of these mighty machines owe much of their ease of operation and maneuverability to hydraulic power—delivered through **EASTMAN** Hydraulic Hose Assemblies.

TODAY'S FARM YOUTH NEVER BORN "30 YEARS TOO SOON"

Milestones in farm mechanization are marked by Allis-Chalmers farm machinery. Pioneering in many farming innovations resulted in such exclusive firsts as the ROTO-BALER, ALL-CROP Harvester, Rear-Engine Tractor—Power Shift Wheels, SNAP-COUPLER and Hydraulic Traction Booster. Much of the operation and control of this world famous line of farm machinery is done through hydraulic power—also applied through **EASTMAN** Hydraulic Hose Assemblies.

NATURE NEVER CRUSHED ROCK LIKE THIS . . .

Hydraulic power on the HYDROCONE crusher affords "one man, one minute" product size control. It provides a rapid and convenient means of raising or lowering the crushing head. It permits compensation for wear and facilitates emptying the crushing chamber in case of power failure or for the quick release of uncrushable materials. Allis-Chalmers pioneered in this type of crusher—as **EASTMAN** pioneered in Hydraulic Hose Assemblies.

TURN TO EASTMAN for *your* Hydraulic Hose Assemblies, too. Whatever your requirements, always get your first recommendation from **EASTMAN** . . . *first in the field.* Exclusive designs, advanced engineering, unequalled production facilities and efficiency—mean unequalled economy, performance and constant customer satisfaction for you.

Eastman

first in the field

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

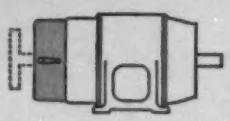
EASTMAN MANUFACTURING CO.
Since 1914
Dept. PE-5, Manitowoc, Wisconsin

WRITE *for free Catalog 101 on Eastman Hose Assemblies*

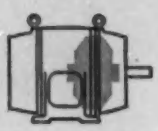
exclusive
REULAND
"Xpandable" design

typical adaptations from this
BASIC DESIGN

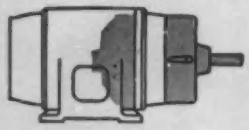
combines motors • brakes fluid couplings • gear-reducers into tailor-made single-unit POWER PACKAGES!



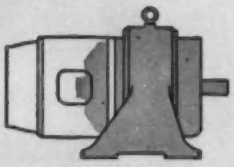
Motor with Reuland "Through Shaft" magnetic brake



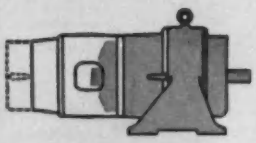
Motor with internal fluid coupling



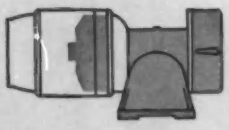
Motor with fluid coupling and brake on output shaft



Motor with fluid coupling and helical gear reducer



Motor with fluid coupling, output shaft brake and helical gear reducer (second brake may also be added)



Motor with fluid coupling, right-angle worm reducer and brake

GREATER COMPACTNESS...
one service responsibility!

Instead of buying and aligning several separate units, install Reuland *tailor-made, single-unit Power Packages.* You save space and weight, reduce prices up to 25%—simplify installation—improve in-the-field performance.

Literally dozens of combinations are available to fit every powering job. All economical, *standard assemblies* using the basic Reuland "XPANDABLE" motor design.

If your equipment utilizes a motor, brake, fluid coupling, gear reducer (or any combination) why not find out first-hand what a Reuland Power Package can do for you. Give us the details and we'll even submit a "tailor-made" test unit on approval.

OVER 800 "SPECIAL" ELECTRIC MOTOR DESIGNS...

Still further versatility is provided by the Reuland "Library of Specials." Over 800 motors with special electrical and mechanical characteristics...800 ways you can save development work, get in production faster!

Write today, outlining your particular power problem. No obligation, of course.

REULAND ELECTRIC COMPANY
Distributors in all principal cities

WESTERN DIVISION: Alhambra, California • EASTERN DIVISION: Howell, Michigan

does not classify it as a technical work. The portion on magnesium is wholly inadequate in that there is practically no description of any of the processing methods for the fabrication of this material.

The author would seem to be unaware of the metallurgical and research considerations which are important. Throughout the work he exhibits a lack of understanding of the problem with which he is dealing. An example to substantiate this criticism is the first paragraph of Chapter 9 on page 55:

> In selecting a magnesium alloy for the production of cast parts, the casting characteristics of the material should be given careful consideration. Preferably, the alloy should have good casting qualities. Briefly, this means that it is capable of being used to produce satisfactory castings with a minimum of wasters. The behavior in casting varies more or less among the different alloys, and the composition to be preferred is the one which causes the least difficulty in the process for which it is adapted.

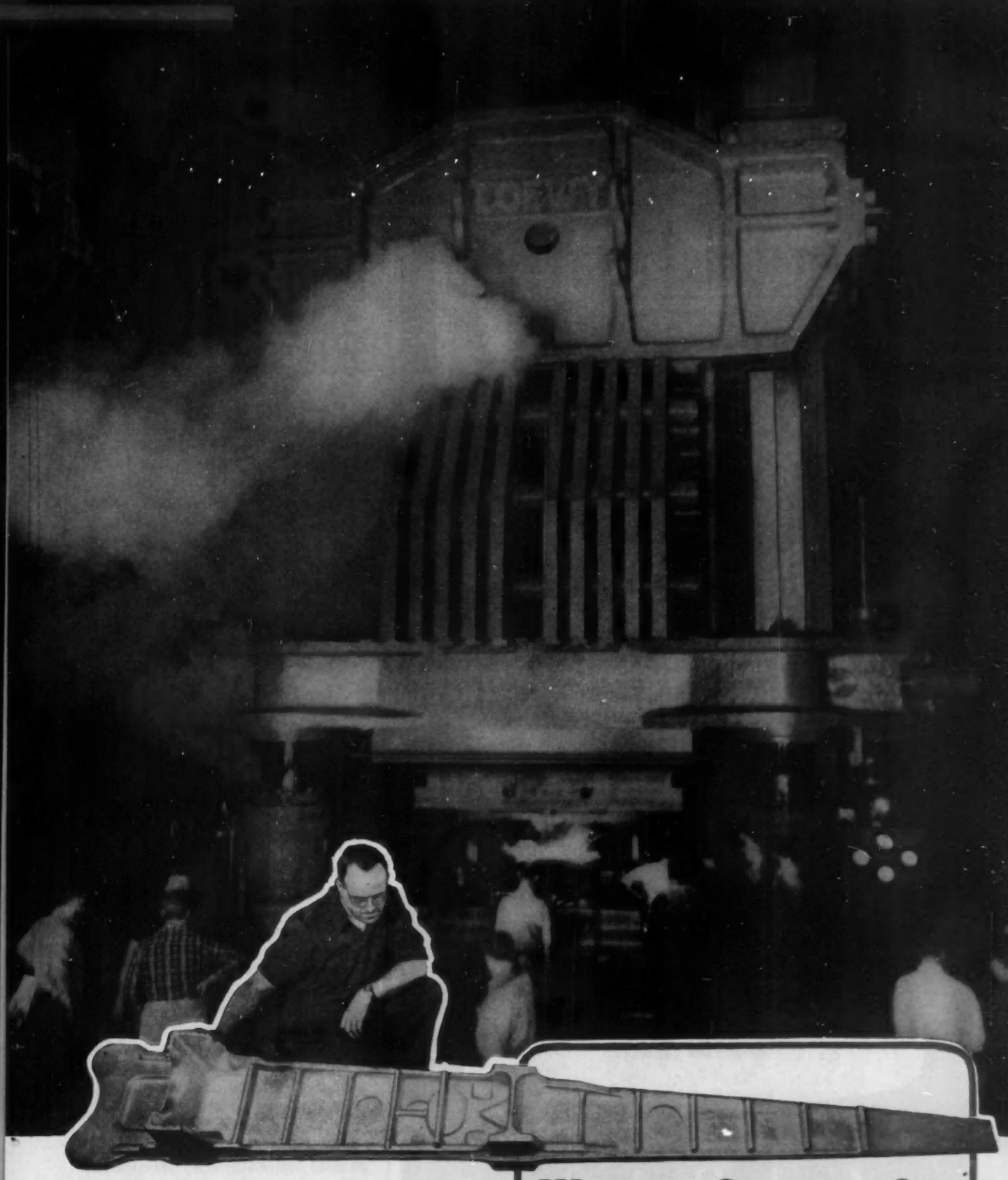
This is the type of thing which prevails throughout the book and leads this reviewer to conclude that this work will not make any important contribution to the library of the engineer or metallurgist.

Storage Batteries

GEORGE WOOD VINAL, *formerly Physicist, National Bureau of Standards.* 9¼ x 6¼, 446 pp. *Fourth Edition. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $10.

This new edition reflects the many technological advances in battery design and construction which have taken place during the past 14 years. It has been largely rewritten in order to bring the reader up to date in the rapidly developing industry.

This book emphasizes the scientific principles of storage batteries, yet retains a practical treatment of the subject. Physical and chemical properties of the materials in batteries are discussed and a general description of the manufacturing practices is presented. The principles of storage battery use are included, covering charging and discharging, constant current charge, modified constant potential



FIRST die forging press in the Air Force Heavy Press Program — 35,000-ton capacity. Now in operation and capable of producing forgings larger than heretofore attempted. Again, as from the beginning of the aviation age, Wyman-Gordon pioneers in scientific advance.

WYMAN-GORDON CO.

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM
STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS
HARVEY, ILL. • DETROIT, MICH.

Hear This!

ANNOUNCING

G.M.I. POLYAMIDE 115

The newest member of Ciba's famous family of resins for industry

Polyamide 115 and Epoxy Resins chemically combine to enable you to reach out toward new and better product design and to achieve lower production costs.

Flexibility, high impact values and good adhesion, are the direct result you can expect with this efficient combination.

Send for new Technical Bulletin No. 8...

"G.M.I. POLYAMIDE 115 AND ARALDITE EPOXY RESINS."

PLASTICS DIVISION
Ciba Company Inc.
627 Greenwich Street
New York 14, N.Y.

CIBA
ARALDITE® Epoxies

charge, boosting, equalizing and trickle charge, floating, system-governed charge, gas evolution, and the effects of high and low temperatures.

Industrial applications are described including telephone service, railway signalling, car lighting, air conditioning, automotive starting on passenger cars, diesel starting, trucks and tractors, shipboard use, aircraft batteries and mining operations.

New material in this edition includes information on improved lead alloys, use of lead calcium alloys, use of uncalcined high-metallic oxides, new types of expanders and separators, use of plastic containers, production of nickel-cadmium batteries, new types of silver oxide cells, 12-v systems for automobiles, and 24-v and higher voltage systems for aircraft. References are included from what the author considers the most valuable papers from literature in this country and abroad.

Advanced Mathematics For Engineers

H. W. Reddick, and F. H. Miller, *Professor and Head of the Dept. of Mathematics, Cooper Union School of Engineering.* 6 x 9 *in.*, 548 *pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York* 16, N. Y. $6.50.

This is the third edition of a book that has become a useful reference for engineers and mathematicians. Covering those topics in mathematics which are essential for an understanding of current developments in engineering theory and practice, the work retains the features that contributed to the popularity of earlier editions and has been expended to cover certain topics even more fully. Particular care has been taken to present definitions, statements of physical laws, theorems, problems, and the physical units employed in the most precise and clear-cut manner.

The work continues to emphasize physical applications by providing, with each principal topic, problems relating to the four major fields of engineering—civil, mechanical, electrical and chemical. The problem lists have been extensively revised and expanded by almost 20 per cent. Answers to all the problems are included.

The book opens with a chapter on the common types of ordinary differ-

ential equations, which also come up again and again throughout the book. Further chapters give a comprehensive treatment of operational calculus, Fourier series, partial differential equations, vector analysis, elliptic integrals, gamma and Bessel functions, and functions of a complex variable. Included in the new material are discussions of Legendre's equation, numerical methods, Laplace transforms, and the reversion of power series.

Directory of Commercial and College Testing Laboratories

8 x 10-½ in., 48 pp, paper cover. *Published by the ASTM, 1916 Race St., Philadelphia 3, Pa.* $1.

This directory is a successor to the directory published in 1947 by the U. S. Dept. of Commerce, Bureau of Standards, as Miscellaneous Publication M 187. Responsibility for its compilation and publication has been transferred to the ASTM by agreement between the two organizations.

The directory lists the locations of testing laboratories equipped and prepared to undertake testing on a commercial or fee basis. Information is given concerning 278 commercial testing laboratories and their 151 branches or offices. There is also presented a list of the laboratories of 86 colleges that are prepared to do testing under certain conditions. Research and consulting laboratories are not listed unless they also are engaged in testing on a commercial basis.

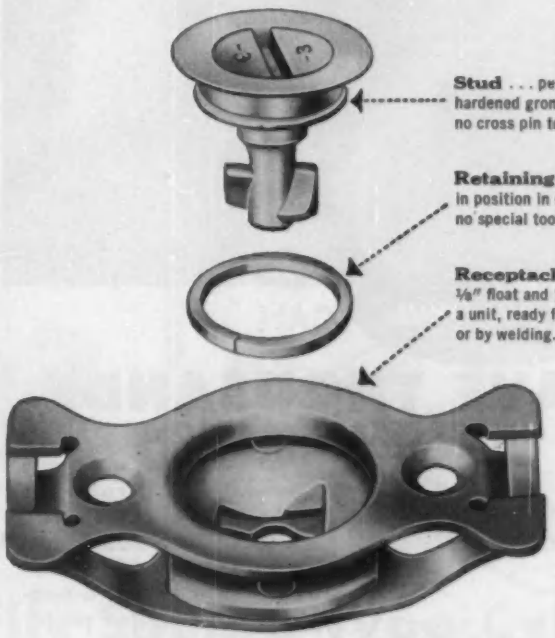
The directory is designed to be of assistance to purchasers not equipped to make their own tests, and who therefore have hesitated to buy on specifications. It will also be of value to small manufacturers and others seeking testing laboratory services.

Although the directory has been compiled from the viewpoint of the testing of commodities, the classification includes a few items not strictly commodities, but which are becoming increasingly important in the fields of manufacturing, construction and sanitation: air (pollution), industrial water and wastes and building constructions.

Using a code system of letters and numbers, a maximum of information is given in a minimum of space. The directory will give the user a good indication of the laboratories most likely to perform tests desired.

New "Style 3" Panel Fastener!

PANELOC introduces Light-Weight, All-Steel Model, Setting Superior Standards in Tension and Shear at a new low price! Only three simple parts to inventory.


Stud . . . permanently assembled to a hardened grommet, comes as one unit, no cross pin to loosen or fall out.
Retaining Ring . . . locks stud assembly in position in one simple operation with no special tools required.
Receptacle . . . all steel, with full 1/16" float and 1" rivet spacing. Comes as a unit, ready for mounting with two rivets or by welding.

Exceptional durability, low price, and simplicity make the new fastener a newsworthy item. It conforms to Specification MIL-F-5591A and is interchangeable with all other "Style 3" fasteners. Let us send you a detailed catalog on the lightest, strongest, most economical "Style 3" Fastener available today.

PANELOC...America's most versatile line of aircraft fasteners...includes Styles 1, 2 and 3 Panel Fasteners, High Performance Fasteners, Rotary Latches and Snap Fasteners.

Fill in Coupon or Write Letter for Catalogs

Scovill Manufacturing Company, Aircraft Fastener Div.
49 Mill Street, Waterbury 20, Connecticut

Please send me fastener catalogs checked:

( ) Styles 1 & 2 (MIL-F-5591A) ( ) High Performance (NAS 547)
( ) Style 3 (MIL-F-5591A) ( ) Rotary Latch
( ) Snap Fasteners (AN227)

Send to:

Name_____ Title_____

Company_____

Address_____

Robotron CAN PROTECT YOUR PRESS DIES FROM BREAKAGE

... through the use of

ELECTRONIC DIE SAVER PRESS CONTROL

Robotron CAN

SAVE THOUSANDS ON PRESS OPERATIONS!

The electronic control that guards the press from double-heading on a non-ejected part.
The detection coil through which stamped parts are directed.

Robotron ELECTRONIC DIE SAVER CONTROL

● Electronically operated, this revolutionary press stamping control guards against the possibility of smashing expensive dies, holds press "down time" to a minimum.

Faster automatic press feeds are possible when this electronic "watch dog" is on guard . . . production is increased . . . operating costs reduced.

Learn the full story of this newest development in press stamping "Die Saver Controls."

See how it can mean the savings of thousands of dollars in your press operations!

Write or wire us today.

Robotron CORPORATION — 21300 WEST EIGHT MILE ROAD, DETROIT 19, MICHIGAN

OUR READERS SAY . . . . . .

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York, 36, N. Y.

Needs Numbering System

To the Editor:

Our current engineering drawing numbering system is inadequate for a project that we are presently engaged in. It must therefore be revised as soon as possible.

We wish to establish an expandable numerical drawing number system by which detail sheets are referenced to sub-assembly sheets, which in turn are referenced to general assembly sheets. The drawing number will be preceded by our project number and a letter to designate drawing size.

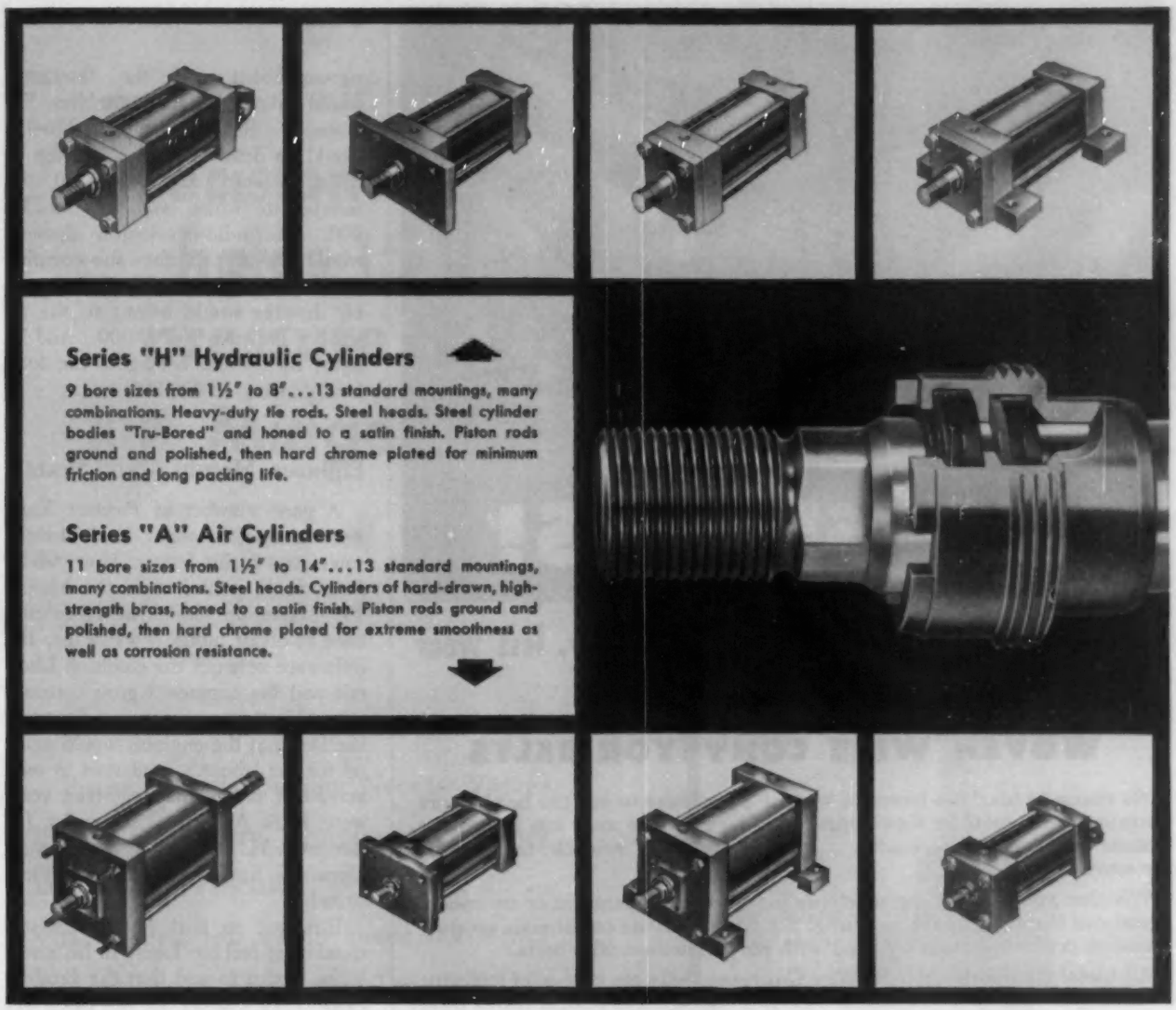
We would appreciate any information or tear sheets that you may have as to existing or suggested systems which would aid us.

—C. M. Carpenter
Wheeler Associates, Inc.

Ed—At one time, and perhaps still, the E. G. Budd Mfg. Co. had a system of numbering drawings which provided such interlocking numbering. The system is applicable in any industry wherein the number of different products and different product designs is not extremely great.

In the Budd system, the first number or group of numbers indicated the product. This first group of numbers expressed millions. Obviously if you were manufacturing a thousand different products it would be billions. But to illustrate specifically, let us say that this is the one hundredth product that is designed. The general assembly drawing number would be 100,000,000.

Now let us start at the other end with the detail drawings. Allow for as much as 999 detail drawings. In other words, the last three digits would indicate the detail drawing number. Then you have three digits ahead of that. You may have 100,000, 200,000, 300,000 and so forth. Each of these would indicate an assembly number. The tens of thousands would indicate



Series "H" Hydraulic Cylinders

9 bore sizes from 1½" to 8"...13 standard mountings, many combinations. Heavy-duty tie rods. Steel heads. Steel cylinder bodies "Tru-Bored" and honed to a satin finish. Piston rods ground and polished, then hard chrome plated for minimum friction and long packing life.

Series "A" Air Cylinders

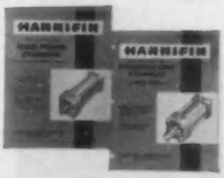
11 bore sizes from 1½" to 14"...13 standard mountings, many combinations. Steel heads. Cylinders of hard-drawn, high-strength brass, honed to a satin finish. Piston rods ground and polished, then hard chrome plated for extreme smoothness as well as corrosion resistance.

Only HANNIFIN Square-Type Cylinders Have This Revolutionary New Gland

The gland you see here represents the biggest improvement in cylinder design in the last 50 years. And, you'll find this gland only in Hannifin Square-Type Air and Hydraulic Cylinders.

This exclusive Hannifin Gland is a bronze cartridge, *externally removable and replaceable as a unit* to meet J.I.C. recommendations. The packing is new, too. Outside is the "Wiperseal." It serves a dual purpose as it *wipes both ways* to provide a dry rod on the out-stroke, a dirt-free rod on the in-stroke. Inside is the "Lipseal"...self-compensating, self-relieving and nonadjustable. It provides an efficient seal throughout its long life.

Find out how easily you can apply Hannifin Cylinders to your requirements. They're available for prompt delivery—in all sizes and all standard mounting styles—and at competitive prices despite all their exclusive features.



WRITE FOR BULLETINS

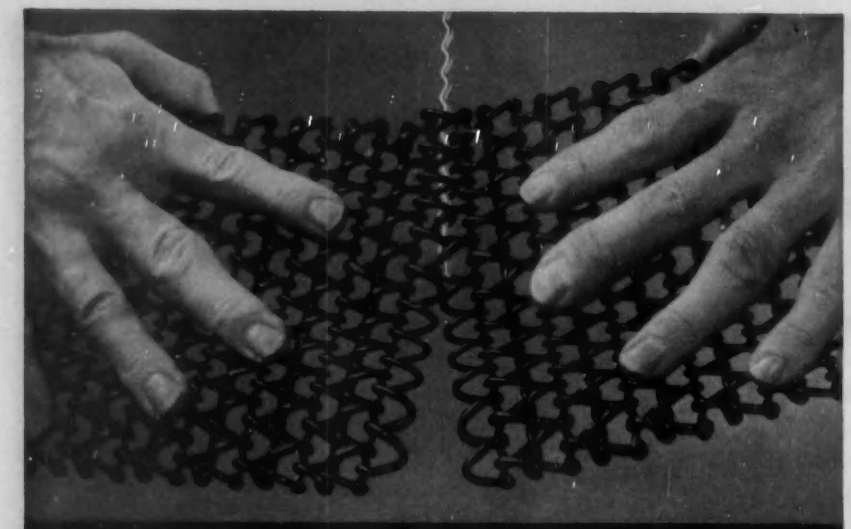
Bulletin 113. Series "H" Hydraulic Cylinders

Bulletin 213. Series "A" Air Cylinders

HANNIFIN

Hannifin Corporation, 525 S. Wolf Rd., Des Plaines, Ill.

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves



NO SEAMS!

Means continuous production with no tear, less wear

on Cambridge

WOVEN WIRE CONVEYOR BELTS

No seams to tear! No lacers to wear! No fasteners to cut the belt! There are no weak spots in Cambridge belts because the ends are joined the same way the belt is made . . . you're assured of smooth, trouble-free operation.

Whether you're designing machines for your own operation or for resale, you can eliminate batch handling, cut costs, provide continuous production at controlled rates of speed with moving woven wire belts.

All-metal Cambridge Woven Wire Conveyor Belts are corrosion resistant and impervious to damage from constant operation at temperatures from sub-zero to 2100°F. Open mesh construction lets process atmospheres circulate freely for uniform cooling, heating, drying . . . provides flash drainage of solutions, rapid washing, quenching, cleaning, draining.

No matter how you look at it, CAMBRIDGE Woven Wire Conveyor Belts are invaluable aids to AUTOMATION . . . help beat your biggest competition, COST. They are made in any size, mesh or weave, from any metal or alloy. Special raised edges or cross-mounted flights are available to hold your product during movement.

Call in your Cambridge Field Engineer to discuss how you can cut ultimate costs by continuous operation. You can rely on his advice. Write direct or look under "Belting, Mechanical" in your classified telephone book.

BAGGED CEMENT . . . Smooth belt won't tear package. Spillage sifts through open mesh to be salvaged.

ASK FOR FREE 130-PAGE REFERENCE MANUAL illustrating and describing woven wire conveyor belts. Gives mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P, Cambridge 5, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

sub-assemblies and the thousands would indicate sub-sub-assemblies. For example, the number 70-236-052 would be detail 52 which belongs to sub-sub-assembly drawing 6-000, the number for which would be 70-236-000. The sub-sub-assembly drawing would belong to the sub-assembly drawing 70-230-000 which sub-assembly drawing would belong to the assembly drawing 70-200-000. And finally, that would belong to the total final drawing 70-000-000.

Eighteen Months—Not Years!

A good number of *Product Engineering* readers caught Fred Heddleson's error in his letter, "How Advise Your Son", published in the March, 1955, issue, pp 306-8. Mr. Heddleson tried to divide monthly wages into the difference between the common laborer's and the engineer's gross earnings at age 35. Among those who discerned the fact that the engineer would make up for the laborer's head start in one-and-a-half rather than eighteen years were: R. R. Audette, R. Schoeller, Jr., Benjamin H. Harrison, E. R. Cramer, Corwin S. Smith, Norman M. Wickstrand.

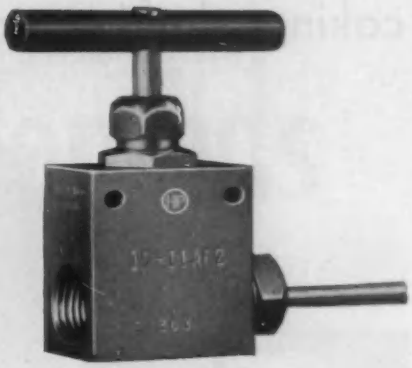
However, so that Mr. Heddleson should not feel too lonely in his error, let us hasten to add that the *Product Engineering* editors did not catch on, either. Just shows how important an alert readership is in keeping editors and their correspondents on their toes. All of this interest in engineering salaries should be worth many more expressions of reader opinion. May we hear from you soon? EDITOR

On Wheatstone Bridge Equations

To the Editor:

The formula Mr. Arnold suggests in his letter (appearing on page 305 of the March, 1955, *Product Engineering*) for use with the Wheatstone bridge-circuit examples given on page 215 of my article, "Wheatstone Bridge Charts," in the September, 1954, *Product Engineering* is an interesting one. It is one which I have not seen previously, but personally find it a little difficult to use for quick mental approximations, since a variation in B, for instance, changes X, K, P and Q.

Precision "O" Ring holds 15 tons pressure in this HIP Midget Valve!



ACTUAL SIZE!

Versatile and compact Needle Valves, by High Pressure Equipment Company, Erie, Pa., use **Precision "O" Rings** to do the vital sealing job which keeps these midgets leak-proof. Pressures—0 to 30,000 PSI!

Precision "O" Rings—always quality controlled, tough, compression molded—your assurance of top, trouble-free performance. Let our engineers help solve **your** sealing problems with the finest "O" Rings made!

Valve body so small—hides behind a 50c piece.

PRECISION "O" RING

FREE—Write for your personal copy of our Handbook on "O" Rings.

Precision Rubber Products CORPORATION

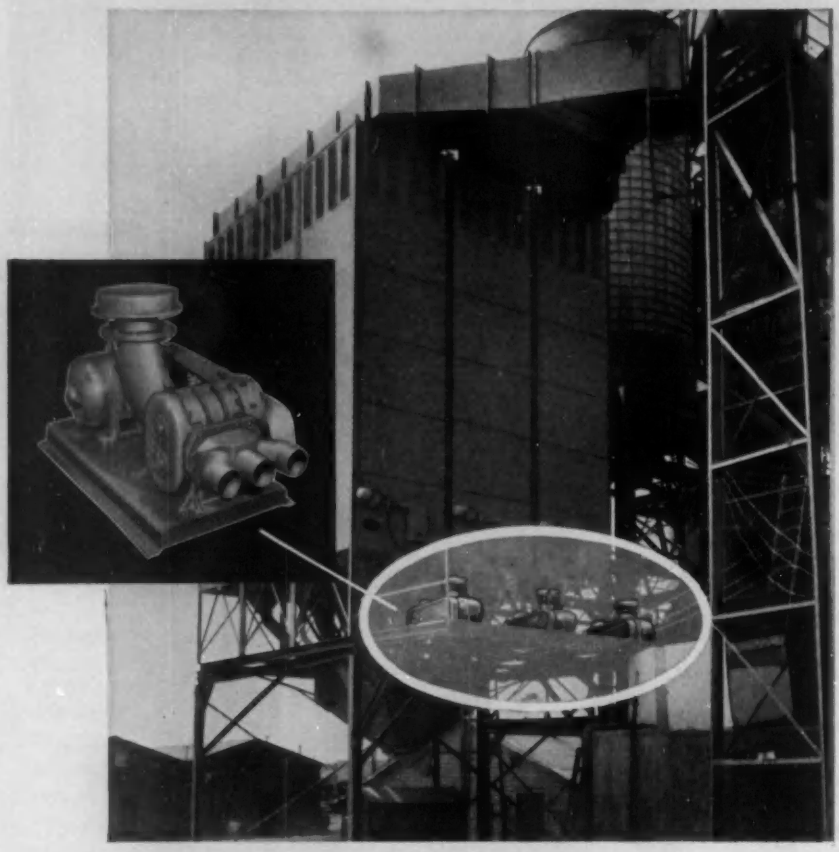
"O" Ring and Dyna-seal® Specialists

Dept 3 Oakridge Drive, Dayton 7, Ohio

Canadian Plant at: Ste. Therese de Blainville, Quebec

MIEHLE-DEXTER BLOWERS

eliminate filter clogging, caking, shaking and disposal



HOW PRECIPITATOR COSTS ARE REDUCED FOR GRAVEL AND ASPHALT PLANT

The nation's growing battle against air pollution focuses attention on the need for modern precipitator equipment. Manufacturers like Western Precipitation Corp. have learned how Miehle-Dexter Positive Displacement Blowers help assure smoke and dust abatement.

For instance, on this Detroit, Michigan installation, located at a gravel and asphalt plant, three belt-driven M-D Blowers provide pressure air for cleaning the filters. Old-fashioned methods of shaking filters clean are eliminated. What's more, there is no clogging or caking of filters... no need for washing them. Costs of operating and maintaining this equipment are reduced.

Miehle-Dexter Blowers save weight and space, require little or no maintenance. *Capacities available:* 50-4000 c.f.m. or multiples thereof with single-drive arrangements. *Discharge pressure:* to 14 p.s.i.g. *Vacuum:* to 15" h.g.

m-d

If you have a product or process requiring dependable movement of air or gas, call on Miehle-Dexter. Our engineers will work with you... demonstrate how Miehle-Dexter Blowers can simplify operation and reduce costs for you. Write for new Bulletin No. 255.

MIEHLE-DEXTER SUPERCHARGER

Division of the Dexter Folder Company

101 Fourth Street • Racine, Wisconsin

I was interested in his comments about reducing the formula to charts. I wonder if Mr. Arnold had in mind using more dimensionless variables than I did to make his charts more general.

Other papers concerning Wheatstone Bridge Equations which Mr. Arnold and your readers might be interested in obtaining are: "Wheatstone Bridge—List of Circuit Equations," *Weston Engineering Notes*, Vol. 1, No. 1; "Design Equations for Bridge Circuits with N.T.C. Resistors for Temperature Indication" for Keystone Carbon Co., April 7, 1945, by Ralph P. Glover, Consulting Engineer, 1024 Superior St., Oak Park, Ill.; May, 1954, and August, 1954, issues of *Right Angle* by Sanborn Co., Cambridge 39, Mass. —WAYNE A. RING
Barber-Colman Co.

25th Anniversary Issue

To the Editor:

I am very much impressed with your Anniversary Issue of January, 1955, and the wide variety of subjects on science and engineering which it covers. —A. R. FISHER, PRESIDENT
Johns-Manville Corp.

We were very pleased with the January, 1955, number of *Product Engineering* and waited until there was an opportunity to review it before replying to you.

I think you have an outstanding edition and have every reason to be quite proud of it.

—GORDON B. CARSON, DEAN
Ohio State University

First of all, please accept my heartiest congratulations on the outstanding features of your Twenty-fifth Anniversary issue. It was a pleasure to talk to your representative last fall as he was gathering material for the article, "Science and Engineering—Today and Tomorrow."

—HAROLD P. KLUG, HEAD
Mellon Institute of Industrial Research

It is an honor and a privilege for the Naval Ordnance Laboratory to be included in the silver anniversary issue of *Product Engineering*. Your feature on "Science and Engineering—Today and Tomorrow" demonstrates

compact · rugged · reliable

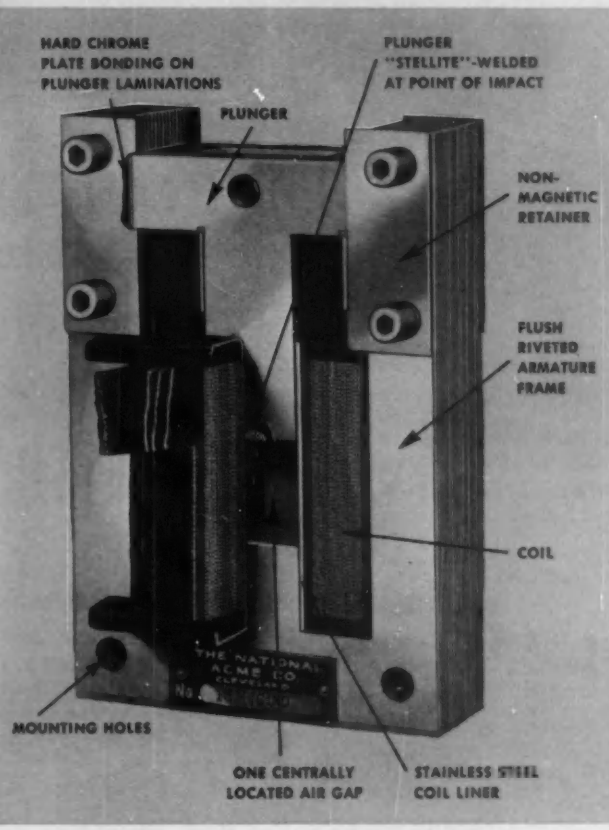
NAMCO "Stellite"-welded

solenoids

assure positive, dependable action, with simplified manufacturing and maintenance

on jobs like these

actuate clutches
operate switches
control machines
print identifying symbols
operate safety devices
eject work in process
actuate clamping
move levers
operate valves
vibrate cutting knives
open and close doors
hold chucks
open and close hoppers
sort inspected parts



Namco Solenoids, with "Stellite"-weld plunger contacts are built in a wide range of standard sizes (2½ to 21 lbs. at ½" stroke and 4 to 25 lbs. at 1" stroke); in push type, pull type, or combination push-pull type. They are available for either AC or DC service, and with standard or special terminal blocks and mountings.

Other types of units for special application are also available—and experienced engineering assistance, to assure the most satisfactory application of Namco solenoids as a thoroughly dependable part of your product, is yours for the asking.

WRITE FOR BULLETIN EM-52. It gives complete engineering data, as well as suggestions for selection of the proper types. Also shows construction and design features and typical applications.

See us at The Machine Tool Show, Sept. 6 to 17. Booths 324 and 705

ELECTRICAL MANUFACTURING DIVISION

THE NATIONAL ACME COMPANY

170 EAST 131st STREET • CLEVELAND 8, OHIO

KEARFOTT
"Penny Size"
Servo Motors and Synchros

Lighter, more compact Servo Systems

Kearfott developed components to fill the need today, for tomorrow's Servo Systems.

SERVO MOTORS

- ¾" Diameter x 1.5" long
  .33 in. oz. Stall Torque
  6500 RPM, 26 Volt 400 Cycle
- ¾" Diameter x .937" long
  .10 in. oz. Stall Torque
  6500 RPM, 26 Volt 400 Cycle

SYNCHROS

- ¾" Diameter x 1.240" long
  Transmitter, Control Transformers, Resolvers and Differentials
  10 minute maximum error,
  26 volt, 400 cycle excitation

Straight thru bore and potted stator construction provide environmental resistance and high order of performance to these Motors and Synchros. Technical data sheets sent on request.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

ENGINEERS:

Many opportunities in the above fields are open—please write for details today.

Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

the careful research and clear writing we have learned to expect from *Product Engineering*. Its interest and timeliness should make it required reading for persons interested in this field.

May we at the Laboratory extend our congratulations on the Twenty-fifth Anniversary of your magazine and wish you continued success for many years to come.

—John T. Hayward
Naval Ordnance Laboratory

You are to be congratulated on your Twenty-Fifth Anniversary Issue.

You have outlined the important fact that science is a tool which increases our potential for good or for evil, equally. The moral obligation to maintain good will and self control becomes increasingly urgent as we increase in wealth and in capability. Your review of engineers who occupy positions of high authority implies to me that the engineering professions are coming into a position to carry more of this responsibility. Are we ready?

The reference on page 167 to carbon brush impregnation recalled the fact that, as a hydro-operator for the Pacific Power and Light Co. in 1940, I noticed that the brushes ran more quietly in humid weather, and theorized that absorbed atmospheric moisture on the commutators functioned as a lubricant.

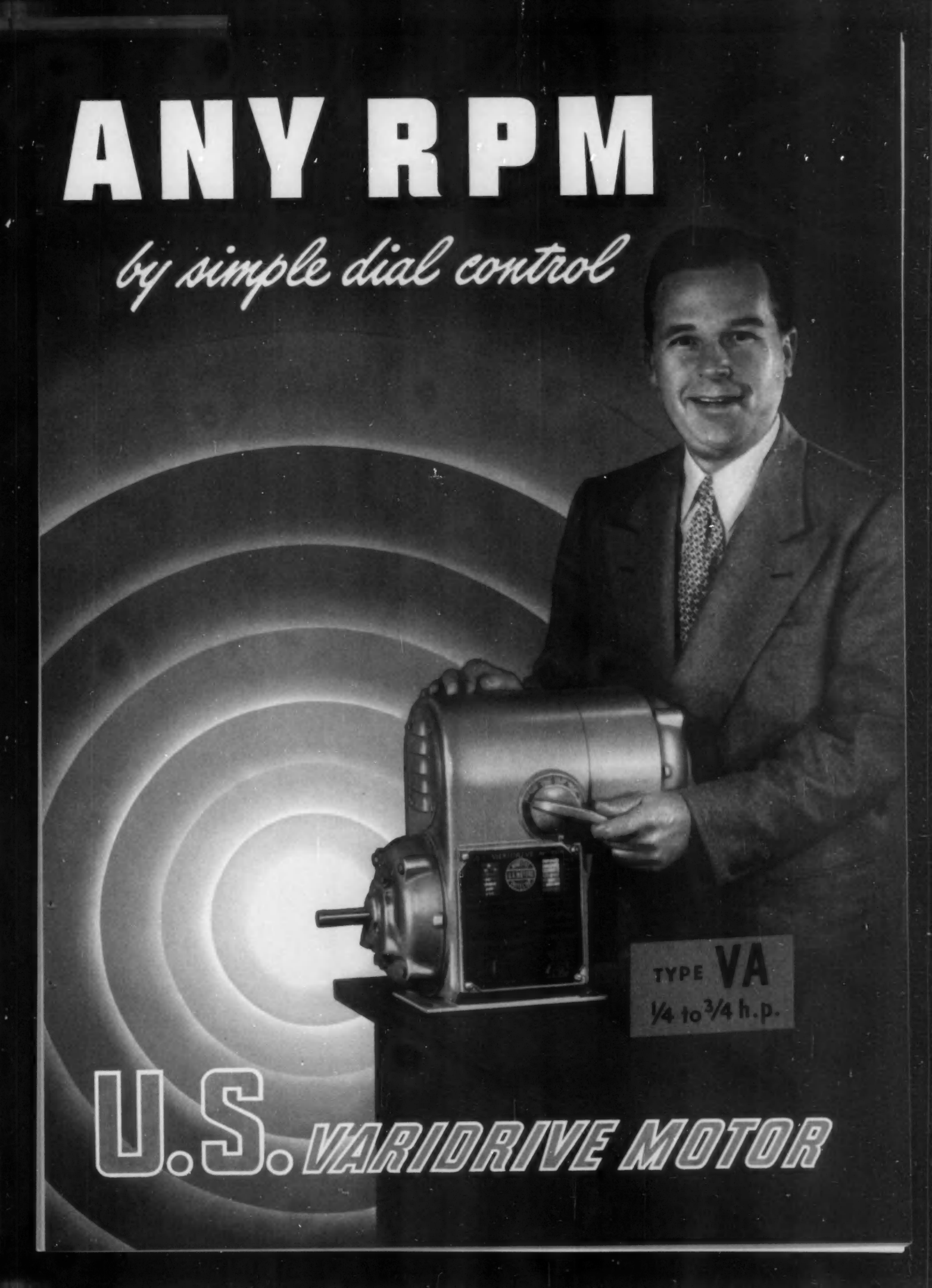
Later that year I became an army procurement inspector at Consolidated Aircraft Co. in San Diego, where the XB-24 was being test flown at the then high altitudes between 20,000 and 30,000 ft. Generator brushes had a service life at those altitudes of 30 to 40 min.

Recalling the previous observation, I suggested that we impregnate some brushes with paraffin wax as a lubricant and observe the result. A number of tests were run with a very encouraging improvement even when one row of brushes in a set were lubricated.

Subsequently, superior pre-lubricated brushes were obtained from outside sources. Under war-time conditions of secrecy we never did know whether our discovery was original. The problem was not anticipated before it arose as stated in the article, unless someone neglected to pass the information to us. —D. L. Smith
Electric Steel Foundry Co.

ANY RPM

by simple dial control

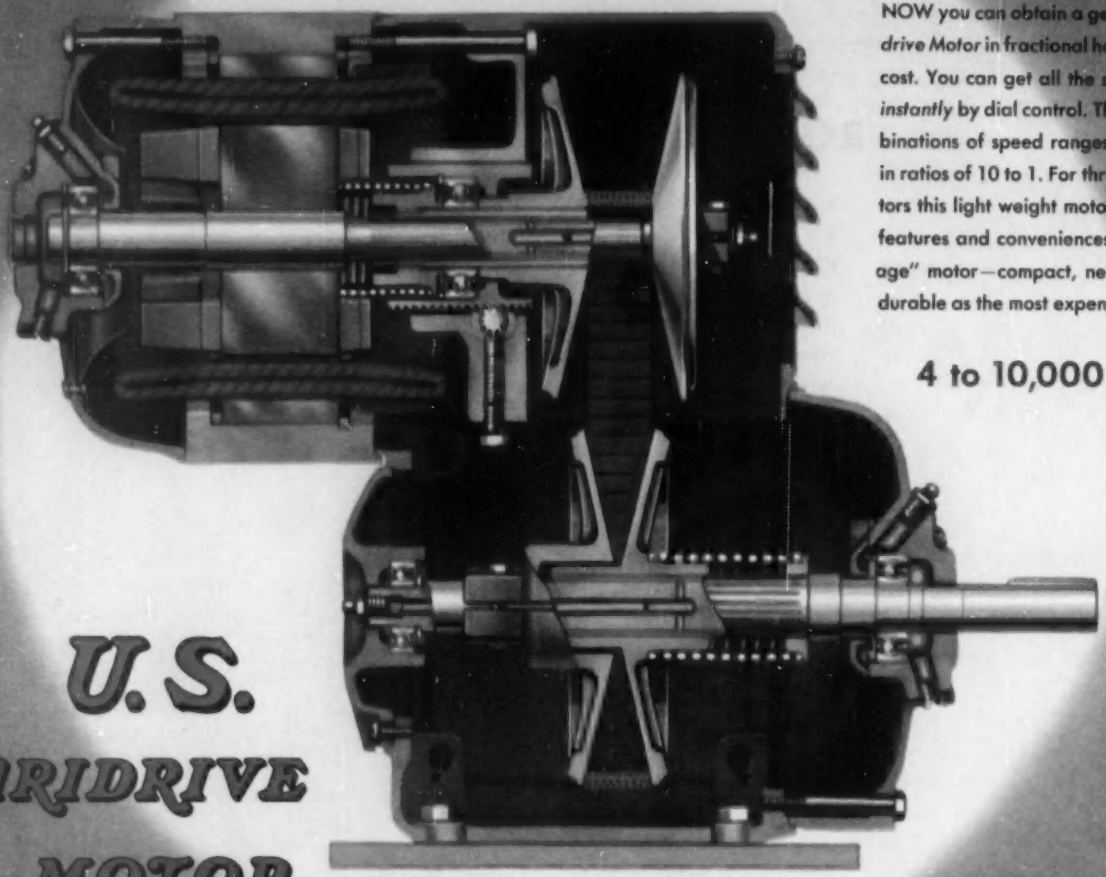


TYPE **VA**
1/4 to 3/4 h.p.

U.S. VARIDRIVE MOTOR

The miracle motor for VARIABLE SPEED

LIGHT WEIGHT — FOR RUGGED INDUSTRIAL DUTY



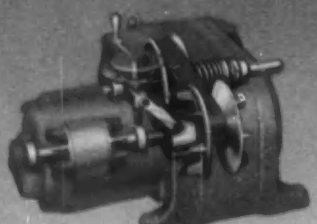
NOW you can obtain a genuine *U. S. Varidrive Motor* in fractional horsepower at low cost. You can get all the speeds you want *instantly* by dial control. There are 24 combinations of speed ranges to choose from in ratios of 10 to 1. For thrifty plant operators this light weight motor is packed with features and conveniences—a "one package" motor—compact, neat, light and as durable as the most expensive design.

4 to 10,000 r.p.m.

U.S. VARIDRIVE MOTOR

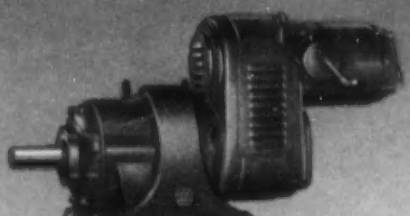
TYPE VA— 1/4, 1/3, 1/2, 3/4 hp

OTHER U.S. VARIDRIVE MOTORS, UP TO 50 H.P.



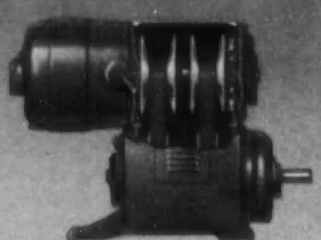
TYPE VE VARIDRIVE

Horizontal type. Take-off shaft can be positioned left or right. All Varidrives embody asbestos-protected windings, normalized castings, Lubri-flush bearings and centricast rotor.



TYPE VEV-GD WITH SYNCROGEAR

Combination type embodying Syncregear, for extra low speeds and high torque. Varidrive unit is mounted on Syncregear, upright as shown above, or can be set horizontally.



VARIDRIVE WITH DUAL BELTS

For extra heavy duty in larger capacities, dual belts are provided. Explosion-proof types and electrical or mechanical remote control also available in horizontal and upright models.

MAIL COUPON FOR VARIDRIVE BULLETIN

U. S. Electrical Motors, Inc.
Los Angeles 54, Calif. (Box 2058) or
Milford, Conn.

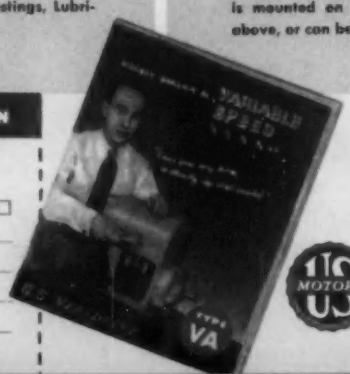
Send VA Varidrive Bulletin ☐ Other Varidrives ☐

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE___ STATE_____



U.S. ELECTRICAL MOTORS, Inc.

PACIFIC PLANT: Box 2058, Los Angeles 54, Calif. ATLANTIC PLANT: Milford, Conn.

Atlanta 3, Ga.; Bakersfield, Calif.; Boston 16, Mass.; Chicago 8, Ill.; Cincinnati 16, Ohio; Cleveland 14, Ohio; Dallas 9, Texas; Detroit 2, Mich.; Fresno 1, Calif.; Houston 4, Texas; Indianapolis 4, Ind.; Milwaukee 2, Wisc.; Minneapolis 2, Minn.; New York City 6, N. Y.; Philadelphia 2, Pa.; Pittsburgh 2, Pa.; San Francisco 7, Calif.; Seattle 4, Wash. Sales and Service offices in all principal cities.

DESIGNING WITH ALUMINUM

NO. 12

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

ROLL FORMING VS. EXTRUDING

ROLL FORMED SHAPES are produced by passing a continuous strip of material through a series of mating pairs of contoured rolls, each of which bends the strip a little closer to the desired form; the finished shape emerging from the last pair of rolls at a rate of from 75 to 300 feet per minute. The length of the shape is limited only by the length of coil stock available. The finished shape is straight and ready to be sawed to usable lengths as it leaves the roll former.

The process was originally a refinement of the draw bench. By adding a pair of contoured rolls to the bench it was found that the finish and shape of the resulting section could be improved and higher production rates attained. Additional stands of rolls were added until they were accomplishing the entire forming operation.

To produce an extruded shape, a die consisting of a flat steel plate containing an opening of the required shape, is clamped against one end of a container which ordinarily takes the form of a cylinder open at both ends. A cast billet pre-heated to a temperature well within the plastic range is placed in the container and pressure is applied through the open end by the ram of a hydraulic press. Hot metal is slowly forced out through the die opening, assuming the shape of the opening. The rate of extrusion varies from one or two feet per minute to as much as one hundred feet per minute, depending on the composition and temperature of the alloy being extruded. Extruded shapes may be twisted as they come from the extrusion press and must be straightened before they are ready for use. Straightening is ordinarily accomplished by stretching. A variety of other equipment such as roll straighteners, gag presses and detwisters is employed to straighten heat treated sections.

Fig. 1. Multiple hole extrusion die.

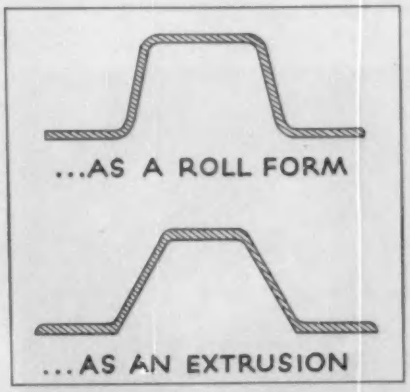


Fig. 2. Trailer side post design. Note more efficient distribution of metal possible with extruded post.

Typical sections produced by the two methods are illustrated in the above drawing. At first glance these sections appear to be quite similar, but closer study reveals several important differences. Since the roll formed section is produced from strip stock it follows that the metal thickness must be uniform throughout the cross section. Extrusions are not subject to such limitations and it is possible to vary the thickness of adjoining sections abruptly through rather wide limits, though the difficulty of obtaining a satisfactory extrusion increases with the disparity in thickness. This fact makes it possible to distribute the metal more efficiently and the stiffness/weight ratio of a properly designed extrusion will equal or exceed that of the corresponding roll formed section.

The thickness of metal which can be extruded is limited by a number of factors having to do with the shape of the section and the alloy to a minimum in the neighborhood of 0.040 in. Roll formed sections can be successfully produced from strip as thin as 0.005 in. and the only restriction imposed by the alloy is that of the minimum corner radius which can be produced without cracking the strip. Even in the most readily formed materials the minimum radius of an outside corner would be the thickness of the material. The corresponding minimum for an extruded section would be about 1/64th inch and would be entirely independent of section thickness.

Extrusions are generally preferred for hollow sections. In certain cases it is possible to produce closed sections by adding an induction welding head to the roll forming machine. This technique is restricted to the production of circular tubing, but will undoubtedly be applied to more complex shapes in the future.

By the very nature of the process, it is inevitable that an extruded section will carry a pattern of fine scratches parallel to its length, which may detract from its appearance in certain applica-

PLEASE TURN TO NEXT PAGE

tions. Roll formed sections begin as a strip of highly finished sheet and if properly handled this finish will not be marred. In fact the normal forming operation improves the finish to the extent that the completed product is more or less polished by the surface of the rolls. This fact leads to a preference for roll formed sections for many applications in the truck body, automotive, building and furniture fields and for many sheet metal, aircraft and household articles where the finish of the formed section is important.

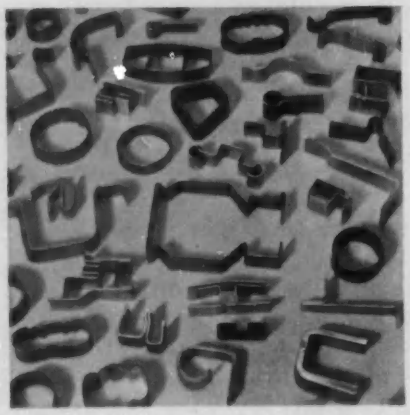


Fig. 3. Roll forming produces an almost unlimited variety of shapes.

Again because they start as sheet, already a fully wrought product, roll formed sections develop higher tensile properties than do extrusions. Because the forming takes place gradually, strain is more uniformly distributed in the roll formed section. Subsequent forming operations required to fabricate the finished product are more easily accomplished than in sections produced by other methods. Where a customer requires a bending or a joggling operation in his finished part, he will find that a cold roll formed part is more easily worked than an extrusion, drawn section or a brake formed part.

It is possible to perform several additional operations by adding suitable attachments to the roll forming machine. By adding a set of coiling rolls at the exit end it is possible to form the section into rings of any reasonable diameter without additional handling operations. Numbering, printing or embossing rolls may be incorporated in the tooling. With embossing rolls, such objects as picture frames, automobile scuff plates, and even jewelry may be formed with the roll design imprinted in the metal.

Rolled sections with inserts of wood, fabric, wire, powdered material, paper and any other substance which can be fed to the machine continuously, are easily formed.

While extrusions do not lend themselves to the application of a repeated pattern while being produced as do the roll formed sections, they may be easily and economically designed to meet specific product requirements. It is easy to add metal from which ribs, lugs and pads may be produced with little or no additional machining.

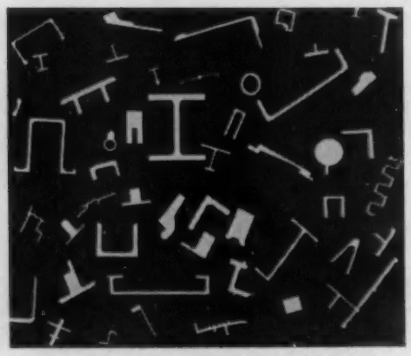


Fig. 4. Cross sections of typical extruded shapes.

The contoured rolls required for the production of cold roll formed shapes are relatively expensive since they require a considerable amount of hand work to match the male and female rolls in each pair exactly. The number of pairs or "stands" of rolls required to produce a given section is directly proportional to the complexity of the section. As many as thirty stands have been used on an especially intricate shape, although this must be considered unusual. Most sections may be formed on machines designed for a maximum of sixteen stands. Once the dies have been made and adjusted, production proceeds at a relatively high rate.

In contrast, extrusion dies are simple and much less costly but production is generally slower. The choice of production method will then be considerably influenced by the total quantity and rate of production which is desired. Relatively long runs are required to amortize the cost of roll dies.

When all properties of the two types of section are considered, it becomes apparent that the title of this article is somewhat misleading. "Roll Forming *and* Extruding" would be more appropriate for each has its special field of application in which the other simply cannot do the job as well.

More detailed assistance with design, alloy selection and fabrication procedures are obtainable through the Kaiser Aluminum sales office listed in your telephone directory, or through one of our many distributors. Kaiser Aluminum and Chemical Sales, Inc. *Executive Office:* 5579 Kaiser Building, Oakland 12, California; *General Sales Office:* Palmolive Building, 919 North Michigan Ave., Chicago 11, Illinois.

Kaiser Aluminum

see our catalog in PRODUCT DESIGN FILE or write for copy

setting the pace—in growth, quality and service

BEARINGS . . .

A Control Factor in Performance!

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Farm tractors give engine bearings a tough test. It's a matter of heavy-load engine operation through long hours in dusty fields . . . and the bearings *have to "take it!"* For quality and dependability, Federal-Mogul engine bearings and bushings are used by many leading manufacturers of farm tractors. Our engineers have specific answers to such application problems. Your inquiry is invited. Federal-Mogul Corporation, Detroit 13, Mich.

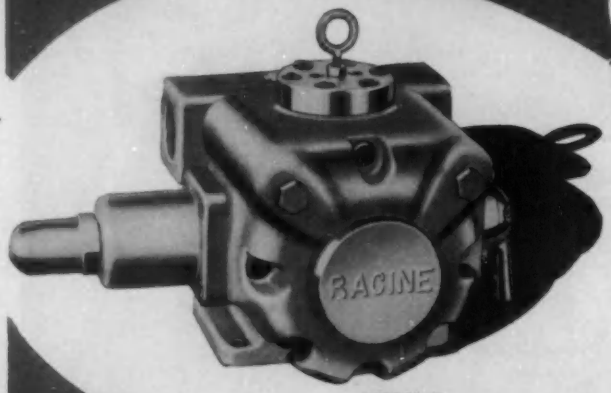
SINCE 1899

FEDERAL-MOGUL

RACINE *Variable Volume* PUMPS

"The heart of any Hydraulic Circuit"

MODEL F
Variable Volume Pump
12 - 30 G.P.M.
Pressures to 1000 p.s.i.



MODEL K
Variable Volume Pump
70 G.P.M.
Pressures to 1000 p.s.i.

MODEL Q
Variable Volume Pump
5 G.P.M.
Pressures to 1000 p.s.i.

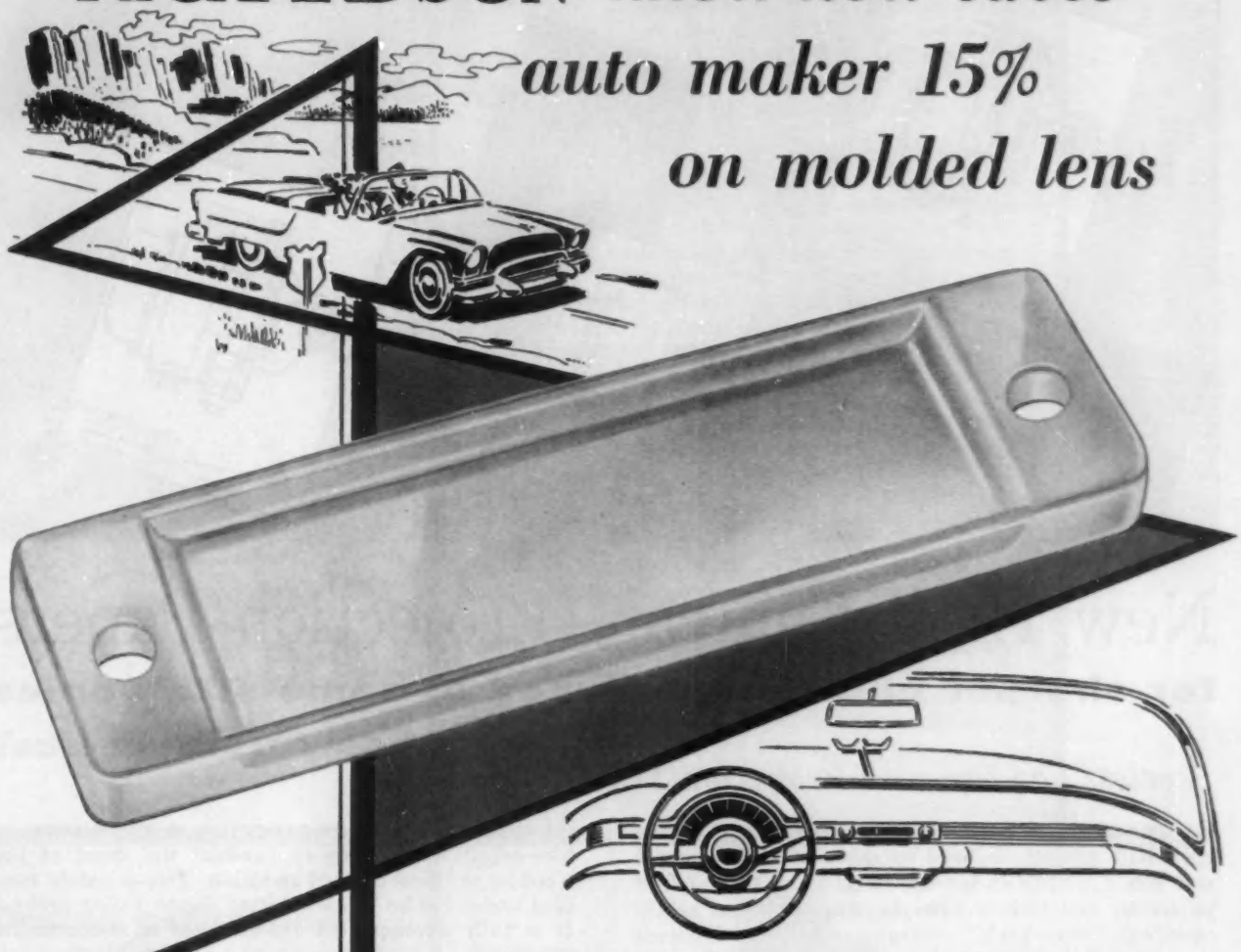
USE RACINE PUMPS, VALVES, PRESSURE BOOSTERS AND RESERVOIR UNITS

"They Work Better Together"

SALES AND SERVICE REPRESENTATIVES IN ALL PRINCIPAL CITIES

Racine Variable Volume Pumps simplify the circuit. They reduce heat losses and save horsepower. Relief and by-pass valves with extra piping are unnecessary. Your initial circuit costs are usually lower. Write for complete catalog and name of your nearest Racine Field Office. Complete engineering service available . . . Address: **RACINE HYDRAULICS & MACHINERY, INC.**, 2073 Albert Street, Racine, Wisconsin, U. S. A.

RICHARDSON *know-how saves auto maker 15% on molded lens*



SIX PLANTS

NEWNAN, GA.

MELROSE PARK, ILL.

OGDEN, UTAH

NEW BRUNSWICK, N. J.

INDIANAPOLIS, IND. TYLER, TEX.

Molded and Laminated Plastics

A well-known auto manufacturer required a clear acrylic molded lens for a dashboard map light. Richardson received the order, made the mold, and was ready to produce large quantities. At this point, the motor company changed the specifications to call for a translucent instead of a clear lens. To make this change, the customer suggested that Richardson sandblast the mold or sandblast the clear acrylic parts. Either process would have added to the cost of the lens.

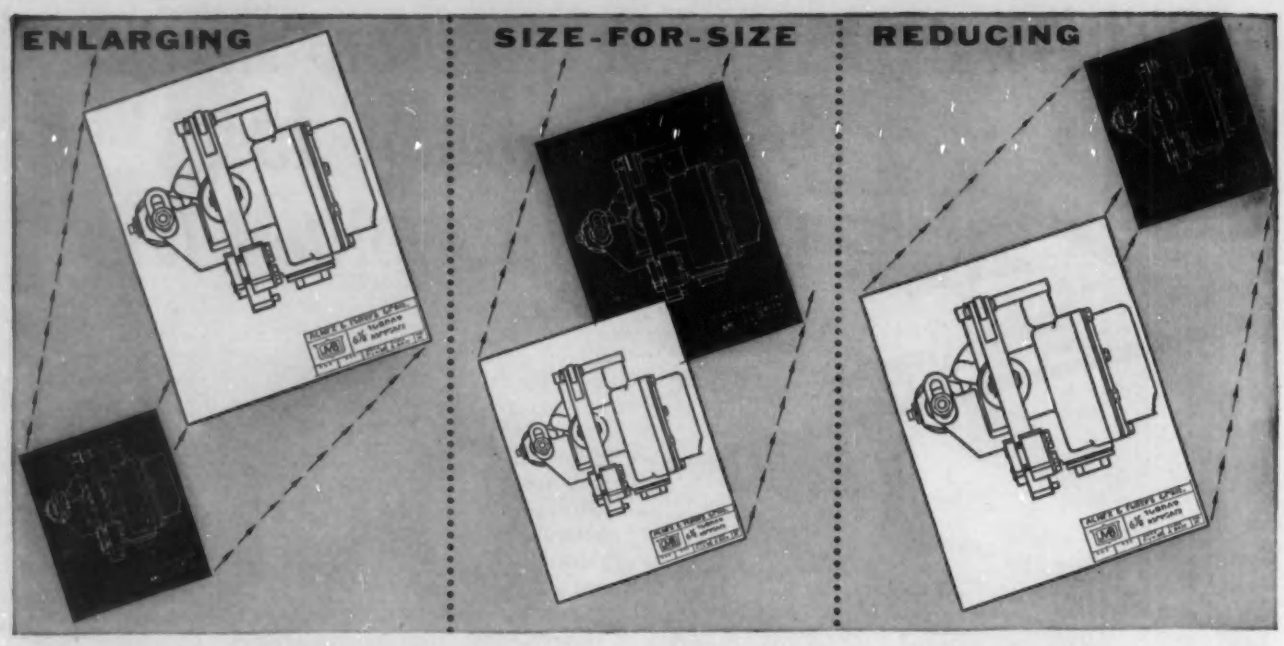
Richardson engineers, with a wide background of experience and knowledge covering many different molding methods and materials, suggested instead a special light-diffusing polystyrene suitable for the application.

Lenses made of this material gave the desired lighting effect, and because of lower raw material cost, the customer received the improved lens at a saving of 15%.

Richardson engineers, with wide experience covering hundreds of plastics materials including the latest developments, would welcome the opportunity to discuss your plastics needs with the purpose of making similar savings for your company. Write or phone today. No obligation, of course.

The RICHARDSON COMPANY

FOUNDED 1858
2793 Lake St., Melrose Park, Ill. (Chicago District)
SALES OFFICES IN PRINCIPAL CITIES



New High-Contrast Projection Papers

for sharper enlarged, reduced or same-size copies

Peerless has two new Projection Papers:

(1) COATED WITH NEOFLOW EMULSION, an orthochromatic projection-speed emulsion of high contrast and density, suitable for use in all types of standard photocopy and process cameras. This emulsion makes excellent "blow-back" enlargements from difficult microfilm copies. It is also ideal for use in the Peerless Neoflow reducing camera. The new emulsion is fully developed in two minutes in conventional developers of the metol-hydroquinone-carbonate type. Handled under Series 1 safelights (red) or the equivalent.

Available on a wide variety of base stocks: standard weight 005 document stock; lightweight 003 extra-thin translucent pure rag stock; transparentized pure rag tracing vellum, specially designed for use as an intermediate on blueprint and diazo machines; and single-weight glossy card, a 135-gram stock with glossy baryta coating, for making file-size prints of engineering drawings or other documents for master record and security files. Furnished either in cut sheets or in rolls spooled for standard photocopy cameras.

(2) COATED WITH PROJECTION B EMULSION, a blue-sensitive emulsion of one-half the speed of the Neoflow projection-speed emulsion. This is safely handled under Series OA safelights (light yellow-green). It is fully developed in two minutes in conventional developers.

It is available on two base stocks: tracing vellum and Peerless Reproduction Cloth, in either cut sheets or rolls. On both of these bases, Projection B emulsion gives copies which make clear, sharp reproductions by blueprinting or the diazo process.

VERY HIGH IMAGE DENSITY—The high silver content of these two Peerless emulsions gives copies with deep rich blacks and good clean whites in striking contrast. Even very fine pencil lines are copied sharply and clearly; letters and numerals reproduce without filling or blurring.

Your Peerless distributor will be glad to supply samples of Peerless Papers coated with Neoflow Emulsion or Projection B Emulsion on any of the stocks listed. Call your distributor, or mail the coupon at left.

PEERLESS PHOTO PRODUCTS, INC. PE-5
Shoreham, L. I., New York

I am interested in testing your Projection Papers for copying _____. Please ask your nearest distributor to show me samples of the Peerless Projection Paper best suited for this work.

NAME_____

COMPANY_____

ADDRESS_____

PEERLESS

PROJECTION PAPERS

Peerless also makes a complete line of high-quality contact photocopy materials and special-purpose industrial photocopy equipment.

Yours for the asking

There's no sense in even *trying* to be an expert in *all* phases of manufacturing today. And there's no need to. For your specialized motor problems, you can turn to Leland's competent sales and design engineers – experts you can "add to your staff" *for the asking.*

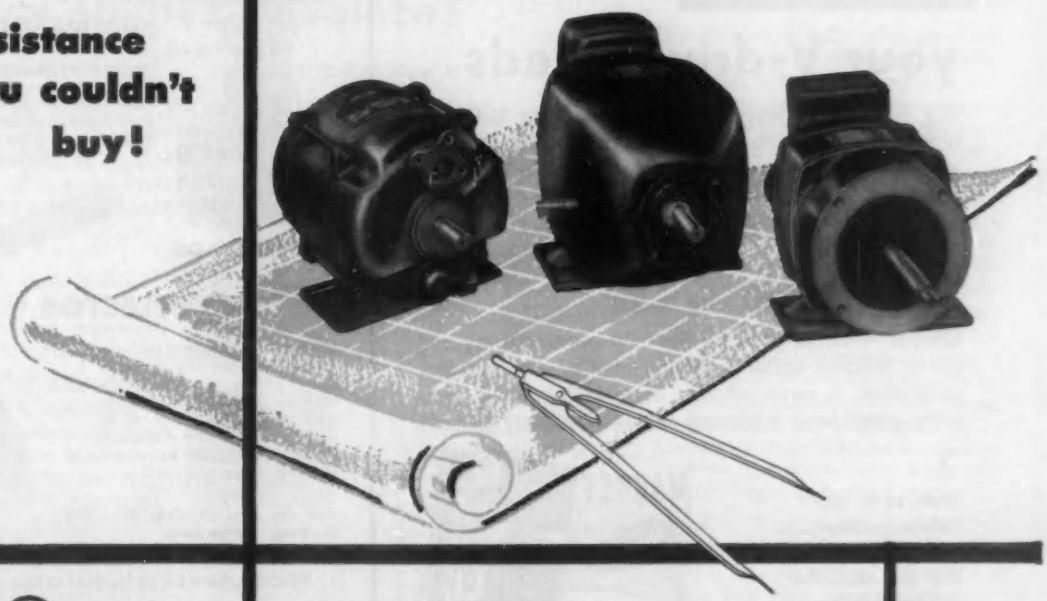
With years of practical experience in serving manufacturers, and a finger-tip knowledge of Leland designs and applications, our representatives can often give you an immediate recommendation. They may confer with our capable staff of skilled design engineers. Often, the design engineer will wish to discuss the problem directly with you, to obtain all the pertinent data needed for a thoroughly practicable solution.

For more than 30 years, Leland has been a leader in the design and manufacture of unusual motor items. And though it has been a constant challenge, sometimes a seemingly impossible one, the reward has been the regularity with which Leland has come up with the answer.

Today, the complete line of Leland motors, standard or special, reflects the wealth of design know-how acquired through developing units for so many widely diversified applications.

Try Leland on *your* motor requirements, from ⅙ to 5 hp. Profit from Leland's experience and the in-built quality of its standard motors. Or consult our representatives in principal cities about your *special* motor problems. Add a real specialist to your staff.

Design assistance you couldn't buy!

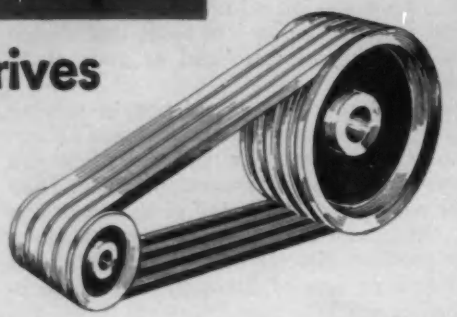


Another AMF Product

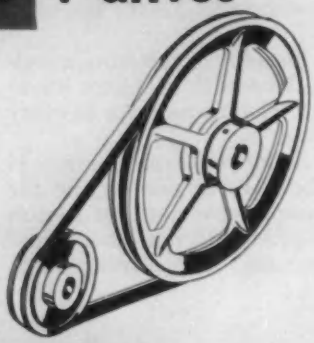
LELAND MOTORS

THE LELAND ELECTRIC COMPANY
Division of American Machine & Foundry Company
Dayton 1, Ohio

whether it's **multiple** v-drives



or **fhp** v-drives



Maurey will meet your V-drive needs

The chances are better than even that your V-Drive requirements can be met in full from the complete stocks of Cast Iron and Pressed Steel V-Pulleys, Sheaves, V-Belts and drive parts in the complete Maurey Multiple and FHP V-Drive lines. If you require special sizes or designs of V-pulleys, sheaves or parts, Maurey is staffed and equipped to meet your needs and stay within your budget.

On any V-Drive problem the help of widely experienced Maurey engineers is available to you *without obligation.* A more efficient drive and lowered cost often result from a Maurey engineering analysis.

Write us of your V-Drive problem . . . today. Ask for Maurey FHP and MULTIPLE V-Drive Catalogs.

maurey manufacturing corporation

2707-23 South Wabash Avenue • Chicago 16, Illinois

The Complete V-Drive Line . . . Serving Industry since 1917

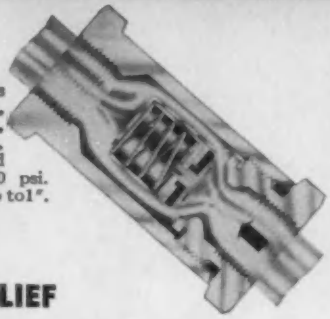
REPUBLIC

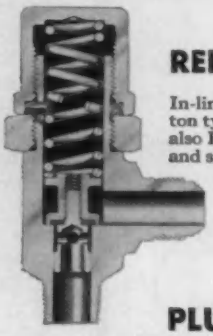
VALVES

INDUSTRIAL • CHEMICAL • AIRCRAFT

CHECK

Quality Check Valves of several types—ball, poppet, Hy-pressure, Free-flow—all metals, various portings, and pressures up to 3000 psi. Pipe and tube sizes up to 1".



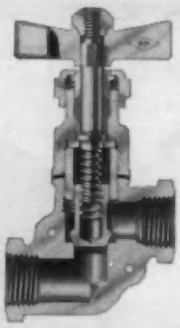


RELIEF

In-line and guided piston type Relief Valves, also Pilot Operated, with quick unloading and silent operation. Metal or rubber seal. ⅛" to ¾" pipe or tube port connections. Various metals.

PLUG

Precision-made Plug Valves for wide general use in brass, aluminum alloy, or stainless steel, ⅛" to 1", +32° to 160°F. With Teflon plug, −65° to 250°F, without lubrication. Aluminum alloy or stainless steel.



GLOBE AND NEEDLE

Super duty shut-off valves, angle and offset, for up to 3000 service, ⅛" to 1". Also high pressure Needle Valves for 10,000 psi. working pressure—proofed at 25,000 psi. One piece, stainless steel, ⅛" to ½", Teflon packing.

LO-TORQ SELECTOR

Directional flow control for service up to 6000 psi. Balancing principle uses line pressure to make turning easy with short handle. 2, 3, 4-way, with various drillings. Side, bottom, and sub-plate porting. Panel mounting.

Ask for new catalog, No. 654, showing entire line.

Distributors in principal cities coast to coast.

150

RM REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

SAGINAW ANNOUNCES:

A REVOLUTIONARY "FIRST"—THE WORLD'S ONLY BALL BEARING SPLINE!

New Saginaw b/b Spline makes all ordinary splines obsolete!

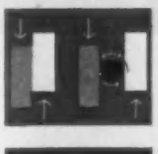
By applying the flight-proved principle of the recirculating rolling ball (already made famous by the *Safety b/b Screw*), Saginaw has *revolutionized spline design!* The new *Safety b/b Spline* is so far superior to any spline ever before built that aircraft engineers are adopting it with open arms—particularly for landing gear applications, where it's a "natural".

In any application where column length must change under torque load, the *Safety b/b Spline* offers unprecedented freedom from spline restrictions.

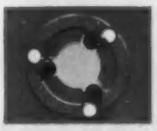
AVAILABLE IN ALMOST ANY SIZE

Every *Safety b/b Spline* is individually engineered for its particular application, with the wealth of know-how that only Saginaw, the pioneer, can offer. Our engineers are ready and eager to help you.

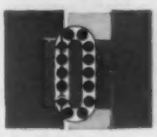
WHAT IT IS AND HOW IT WORKS:



Let's start with the familiar principle that there's far less friction in *rolling* than in *sliding*. The average coefficient of friction of the sliding spline is .2—while that of the ball/bearing spline is only .005.

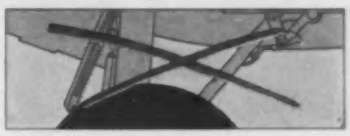


By applying this principle, the *Safety b/b Spline* radically increases the efficiency of transmitting or restraining high torque loads. Instead of *sliding* against each other, the mating surfaces *glide* on rolling balls.



The steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of both the inner and outer splines. Ball guides return the balls to their starting point.

HOW THE Safety b/b Spline CAN HELP SOLVE YOUR AIRCRAFT ACTUATION PROBLEMS



The *Safety b/b Spline* offers great advantages over the conventional "scissors" unit in landing gears.

The coefficient of friction of the *Safety b/b Spline* is approximately 40 times better than that of the conventional spline. It can be fitted with integral gears, clutch dogs, bearing and sprocket seats or other attachments for use with electrical, hydraulic or pneumatic units—forming a unit with tremendous advantages for the aircraft engineer. It can enable you to:

ACHIEVE THE "IMPOSSIBLE"—By reducing weight and space requirements, the *Safety b/b Spline* permits engineering designs hitherto impractical.

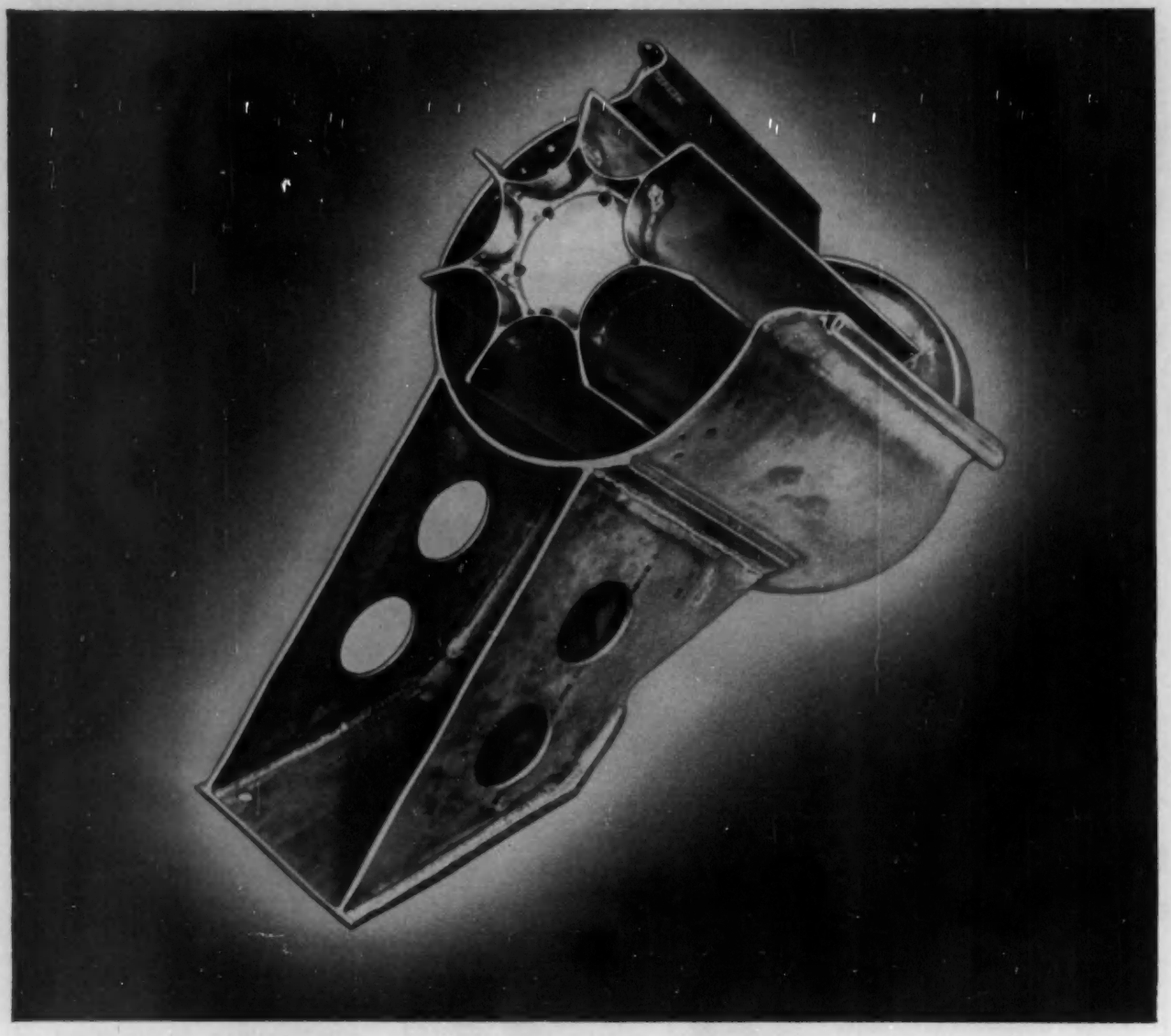
INCREASE DEPENDABILITY—Greatly decreased friction means less wear—longer life—safer, more dependable operation is assured.

SEND FOR FULL DETAILS TODAY!

New *Safety b/b Spline* Bulletin includes design data to facilitate your preliminary planning. Just write on your company letterhead for

Safety ball bearing Spline by Saginaw

STEERING GEAR DIVISION • GENERAL MOTORS CORPORATION • Saginaw, Michigan



TITANIUM cuts weight more than 50%...

Formerly made of steel, this magazine for a U. S. Navy gun mount weighed 198 pounds. Now, fabricated of REM-CRU A-70 *titanium* by Universal Match Corporation, this same part weighs only 95 pounds—*a weight saving of 103 pounds*. And due to the excellent fabrication characteristics of REM-CRU A-70, only minor design changes were necessary when production was shifted from steel to titanium.

Titanium's high strength-weight ratio may be just what you need, too. Or, perhaps more important to you, is titanium's exceptional resistance to most forms of corrosion. And remember—titanium can be machined, formed from sheet, forged or welded by normal shop practices.

Don't overlook the advantages of titanium for your jobs. You can get the sizes, grades and shapes of REM-CRU titanium you need *quickly* . . . for REM-CRU's expanded facilities make ample quantities available. And if you'd like, a REM-CRU engineer will be glad to help you make the best use of this versatile new metal.

To keep abreast of the latest developments on this vital metal, write to Dept. P-5 for the Rem-Cru Review — a free periodical presenting the latest technical data on titanium alloys.

REM-CRU TITANIUM

REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

Koven

WAS MAKING INDIVIDUALIZED EQUIPMENT PARTS

The resourcefulness and ingenuity which characterized the Oklahoma homesteaders also had its counterpart in the industrialized East—where progressive equipment manufacturers were already reaping the benefits of KOVEN Individualized Equipment Parts. Even then, KOVEN special parts were speeding production and cutting costs in leading equipment plants. Today KOVEN units—built to the exact needs of an operation—are an integral part of the industry's unceasing effort toward greater efficiency. See how KOVEN can fabricate the specific parts efficient production requires... faster and usually at lower cost than would be possible in your own plant. Call or write for a consultation—no obligation. Send for Bulletin #550.

X-RAY INSPECTION FOR QUALITY CONTROL

Our complete modern facilities include: Machine, welding, plate and sheet metal, galvanizing and welding shops.

Fabrication to all A.S.M.E. Codes

Specialists in:
STAINLESS STEEL, MONEL, NICKEL, ALUMINUM, INCONEL, ALL CLAD MATERIALS

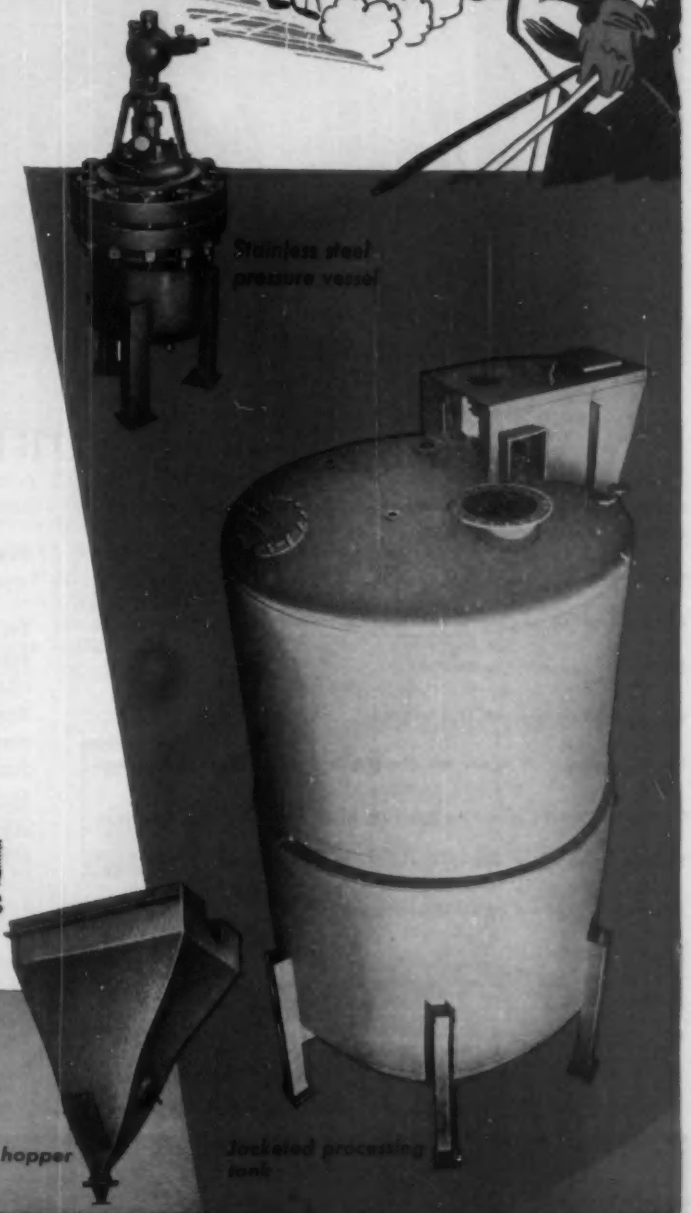
Plants:

Jersey City, N. J.

Dover, N. J.

Trenton, N. J.

L. O. KOVEN & BRO., INC.
154-C Ogden Ave., Jersey City 7, N. J.

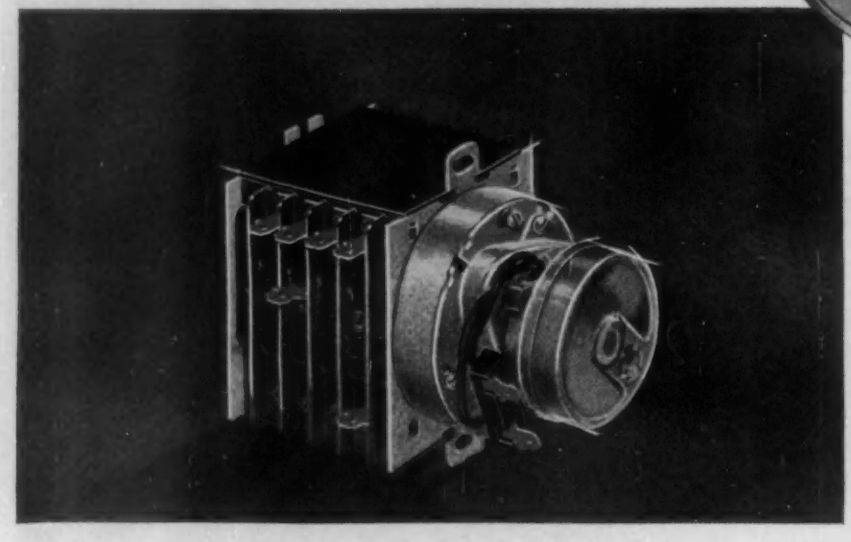


KOVEN FOR INDIVIDUALIZED EQUIPMENT SINCE 1881

for CONTROL...

of time intervals in sequence
it's time you checked

the Soreng Timer



If your development project or present production requires an interval timer for programming an automatic washing-machine, dryer, dish-washer, window-fan, etc., then now is the time for you to check the Soreng Timer . . . and investigate the advantages of custom-engineered timers at low mass production prices. As a starting point, let us consider some of the characteristics of THE SORENG TIMER.

about the SORENG timer

Eight Double-throw switches with off position. Axial manual shaft on-off switch, available in out-off or out-on position.

Will control up to 16 different circuits.

Short interval circuits can be provided for spray or signal purposes.

Rating: To customer specifications.

Choice of bullet or spade type terminals.

Manual control shaft ¼" dia. with threads, flats, etc., to your specifications.

Clockwise rotation providing indexing of 45 and 60 distinct positions.

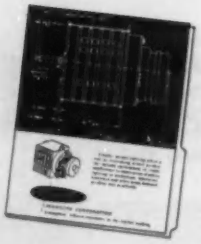
Shaft may be rotated counter-clockwise without damage.

Accuracy is obtained by synchronous timer motor.

Tandem or lateral motor drive arrangement.

Stepping control mechanism is simple in design and ruggedly constructed.

In keeping with the Soreng policy of engineering products to our customers' specifications, the timer characteristics provide ample latitude for your specifications to be incorporated in the basic design. For more complete data, drawings and our "Timer Cycle Analysis Form," write for Timer Bulletin SL-2 . . . it's the next step to custom-engineered timers at mass production prices.



Timer Bulletin SL-2

SORENG

• PRODUCTS CORPORATION

9563 Soreng Avenue, Schiller Park, Illinois

Plants: Schiller Park, Ill., Fremont, O., Spring Valley, Ill.

OTHER SORENG PRODUCTS FOR THE APPLIANCE, AUTOMOTIVE AND AIRCRAFT INDUSTRIES

Solenoid · Selector Switch · Timer · Snap Switch · Push-button Switch · Door Switch · Solenoid Valve

HOWELL MOTOR BRIEFS

Quick facts for those who design-in and specify electric motors

Disc Motors . . . Space Savers Unequalled!

Here's the way to reduce the space occupied by a motor and still get performance characteristics equivalent to those of a conventionally designed motor. Depending upon horsepower, Howell Disc motors will effect length reductions of between 42 and 50 percent, with only a very slight increase in overall diameter.

This drastic space saving results from flattening the end plates and recessing the bearings into the motor. Howell is one of the few manufacturers who furnish disc motors (sometimes called "pancake" or "wafer-type") as a standard item.

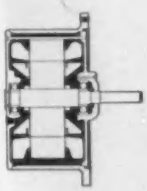


Fig. A

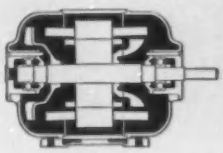


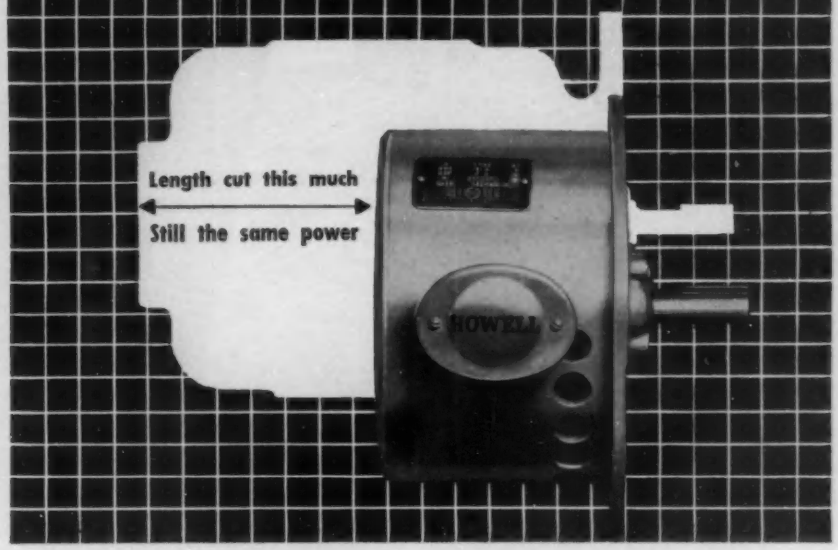
Fig. B

Fig. A, showing the Howell disc motor design, illustrates how the bearings are recessed into the rotor. Compare this with Fig. B, showing conventional motor construction. Both designs provide ample copper wire and lamination steel in the motor.

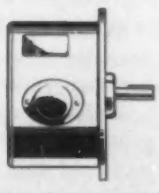
As compared to other disc motors having the rotor recessed into the stator, Howell's disc motor design has these advantages: (1) Effects a greater reduction in size; (2) Has no axial air gap to vary and cause motor "howl" or power loss, when bearings wear over an extended period; (3) Service, if ever needed, is simplified because of the conventional rotor and stator construction.

It's a tried and proved design — Howell Disc Motors have been used with excellent results on machine tools, punch presses, cranes and hoists, among many other applications . . . and new uses are being developed constantly. Because there are no ventilation ports in the end plate at the pulley end of an open-type disc motor, it's ideal for vertical, shaft-up mounting.

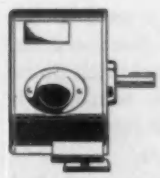
Howell can furnish all the electrical types available in conventional motors — multi-speed, high torque, high slip; single or polyphase; Class "B" or "H" insulation included. They're readily combined with the Howell friction brake to make an extremely compact and efficient type of brake motor.



They are offered as standard motors in Frame sizes 56 through 32, both in open and enclosed, fan-cooled constructions. Mountings: either NEMA "C" face end plates or foot-type as illustrated.



FLANGE MOUNTING



FOOT MOUNTING

Sizes range from ¼ to 20 h.p. at 1800 rpm, including intermittent hoist types.

Write for Bulletin DT-1

Howell's distinctive motor construction, as applied to the disc type motor, includes such features as these:

High-quality insulation. Seven different pieces of insulation for each slot cell. Complete insulation between top and bottom coils and between all phase groups. Lead wires brazed to coil ends and insulated with vinyl chloride plasticized fiberglass tubing.

Copper-clad rotor. Copper bars and end rings are welded or brazed together for unusual strength. High melting point of copper prevents damage from high temperatures caused by possible over-loads.

Expert craftsmanship. Rotors are ground to precision limits for exact concentricity and uniform air gap. They are dynamically balanced at rated speeds.

High-quality coil varnish. Entire stator is thoroughly impregnated twice with the finest phenolic resin-base varnish, twice baked for extra protection.

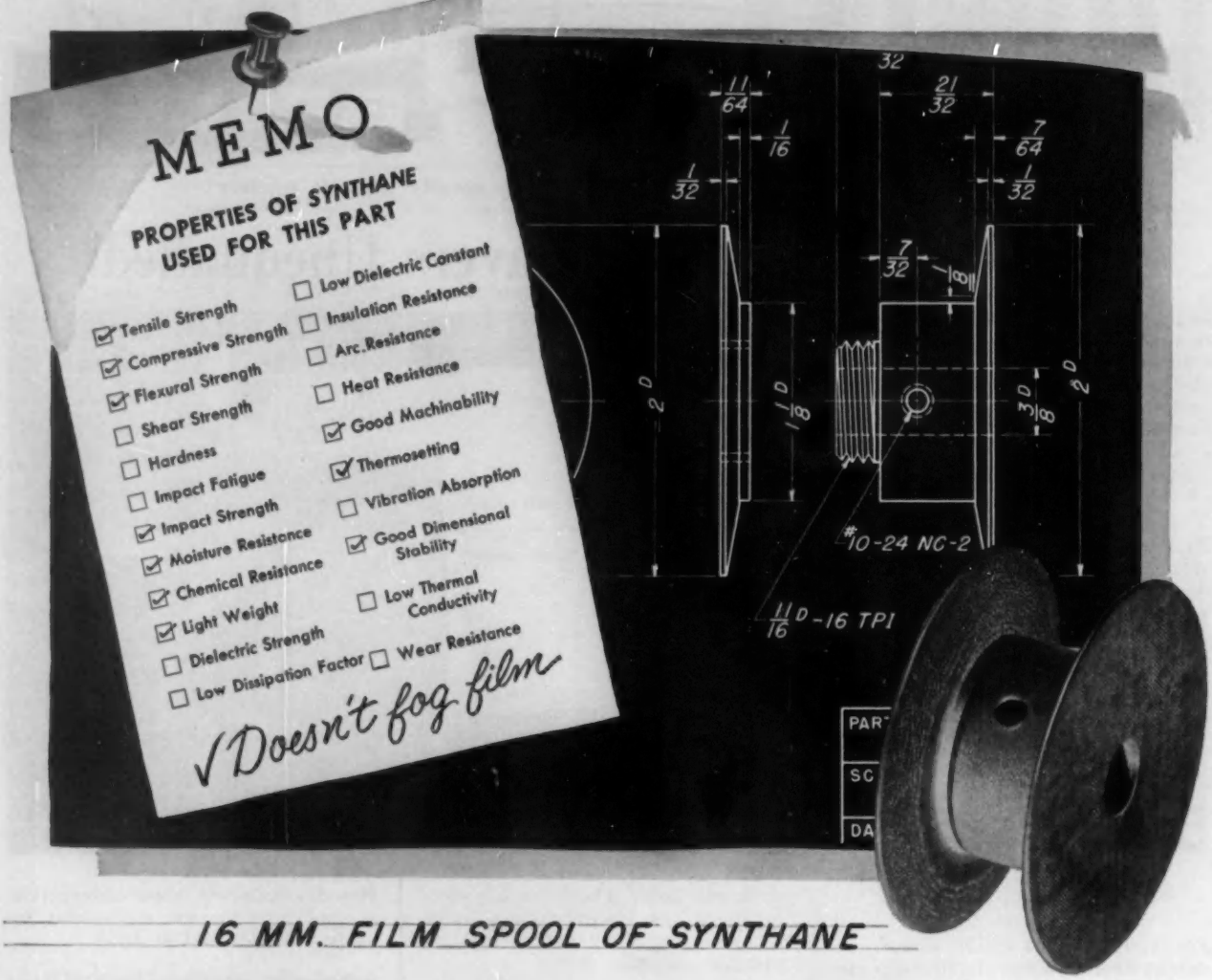
Leakproof oil seals. Provide dependable, dirt-free operation.

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

YOU FURNISH THE PRINT, WE'LL FURNISH THE PART



16 MM. FILM SPOOL OF SYNTHANE LAMINATED PLASTIC RESISTS PHOTOGRAPHIC CHEMICALS, HOLDS SHAPE, DOESN'T FOG FILM.

The film spool we're talking about is one used in the processing of movie film. The material for this spool has to be light in weight, strong and easily machined. Since it is always in contact with film and photo solutions, it must also be chemically-resistant and—most important—not fog the film by chemical contamination.

This isn't an easy assignment for any material, but *Synthane* fills the bill.

Whenever you want parts requiring many properties, consider how *Synthane's* combined benefits may help you improve your product.

Synthane produces finished parts from many different grades of *Synthane* laminated sheets, rods, tubes and molded-laminated and molded-macerated parts. Service and quality characterize *Synthane* fabrication.

We can handle the whole iob for you from your print to the finished part—eliminating your tooling-up, reject and machining problems—and producing parts of excellent quality at a saving of your time and money.

For more information about *Synthane* grades, properties and fabrication facilities, send in the coupon.

SYNTHANE CORPORATION, 4 River Road, Oaks, Pa.

Please rush me more information about *Synthane* laminated plastics.

Name_____

Title_____

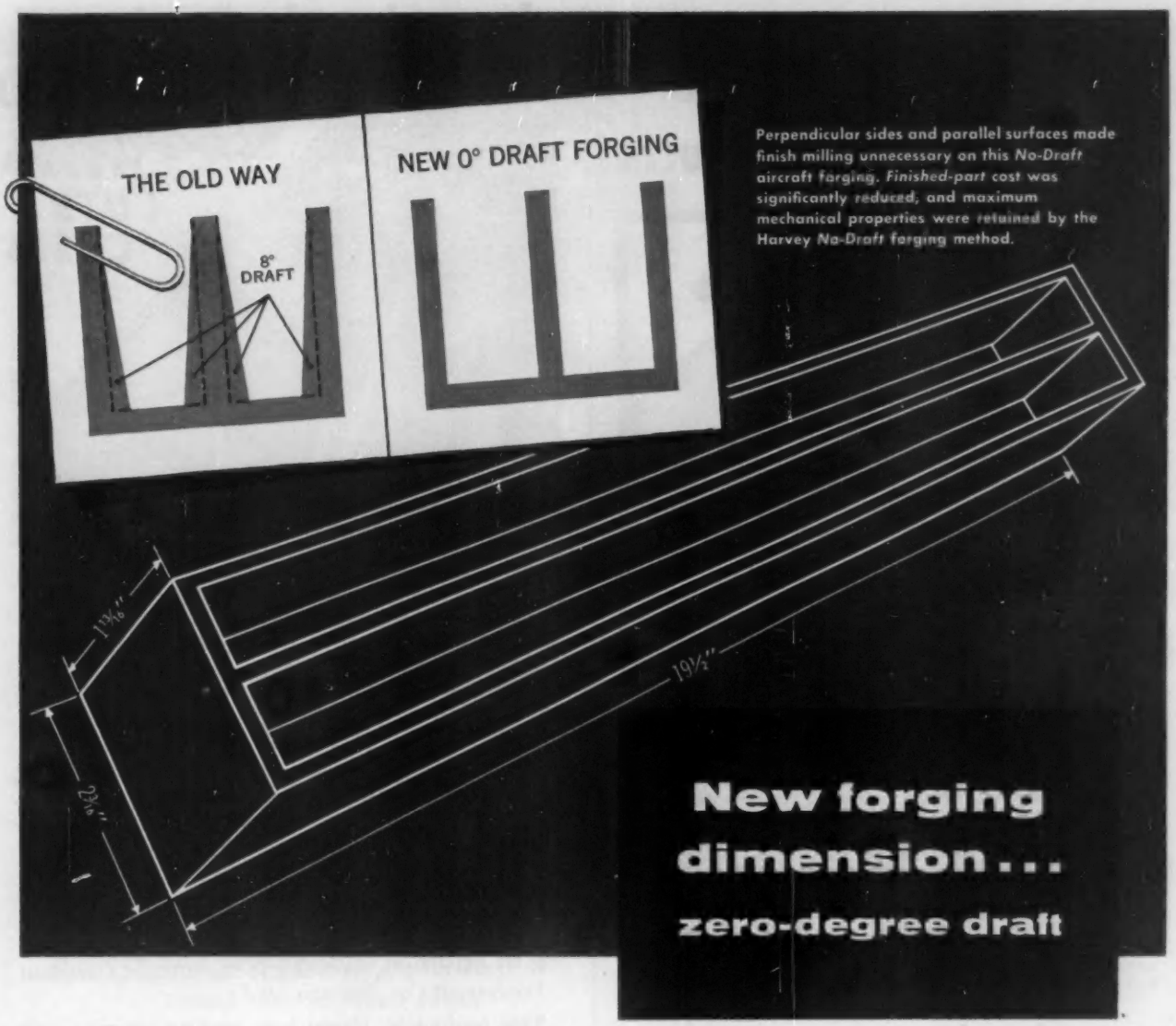
Company_____

Address_____

City_____ Zone_____ State_____

SYNTHANE
LAMINATED S PLASTICS

SYNTHANE CORPORATION • OAKS, PENNSYLVANIA


THE OLD WAY
8° DRAFT
NEW 0° DRAFT FORGING
Perpendicular sides and parallel surfaces made finish milling unnecessary on this No-Draft aircraft forging. Finished-part cost was significantly reduced, and maximum mechanical properties were retained by the Harvey No-Draft forging method.
1 13/16"
19 1/2"
2 3/4"
New forging dimension . . .
zero-degree draft

For structural members, tools, hydraulic components and similar high-stressed parts, there's just no substitute for tough, lightweight aluminum forgings. Their strength makes it possible to increase loads significantly without adding to size or weight.

Now, Harvey goes one step farther and brings you *No-Draft* Aluminum Forgings that eliminate complex machining between forging and final product and reduce the all-important *finished-part* cost. Excellent working properties and minimized scrap lower cost even further.

Let Harvey help you improve your final design with a *No-Draft* forging so that you actually buy "parts instead of raw materials."

For your aluminum needs, call a Harvey Field Engineer today. His one job is to put *custom-designed* aluminum to work for you. Besides *No-Draft Forgings*, he can help you with other important forms of press-forged aluminum such as:

- *impact extrusions or impact forgings*
- *close-tolerance forgings*
- *hand forgings*

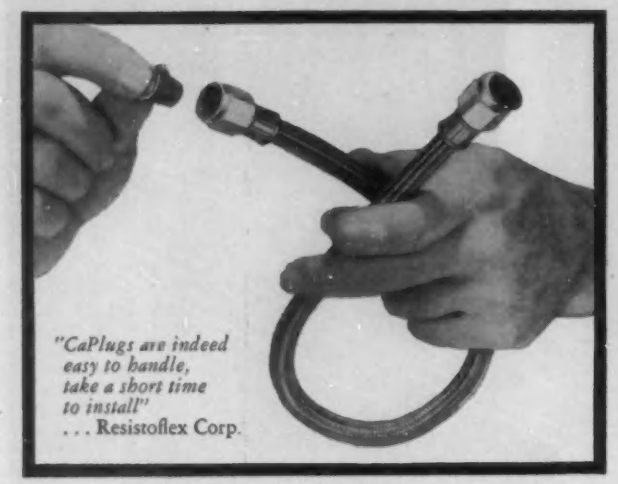
MAKING THE MOST OF ALUMINUM . . . FOR EVERYONE

HARVEY Aluminum

HARVEY ALUMINUM SALES, INC., TORRANCE, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES

An independent producer of aluminum extrusions in all alloys and all sizes, special extrusions, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tubes, impact extrusions, aluminum screw machine products and related products. Also similar products in alloy steel and titanium on application.

see how CaPlugs can protect your products



Just push them in! That's how Resistoflex applies CaPlugs to keep aircraft hose assemblies clean.

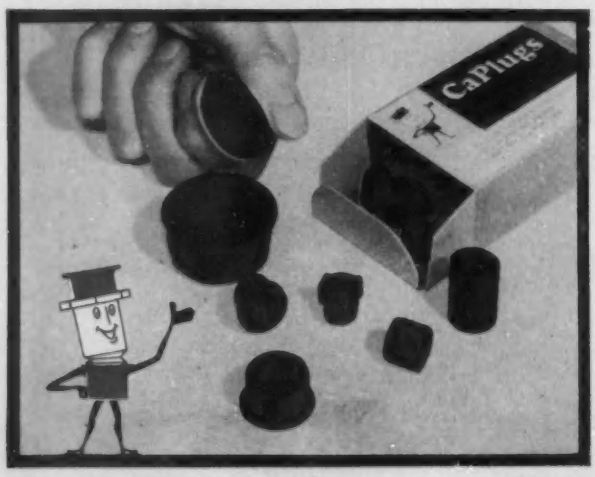
Because they're flexible, these tapered, non-threaded closures slip on easily over plain or threaded fittings or insert readily into round openings . . . to safeguard products during process, storage and transit.

Already in use by thousands of industries on numerous types and makes of tubing, valves, hydraulic components, fittings and machined parts, CaPlugs are easy to spot. *They're red!*

Made of Polyethylene, CaPlugs will not collapse, chip, break or shred under most severe conditions . . . are impervious to all common chemical reagents, acids and solvents. They're plenty *tough* . . . yet extremely *kind* to threads and polished surfaces.

Furnished in five standardized cap and plug designs (both threaded and non-threaded), CaPlugs are stocked in over 200 sizes (up to 8" in dia.) to meet most needs. Make sure you receive complete details and prices.

write for this FREE assortment



CaPlugs

DIVISION

PROTECTIVE CLOSURES CO., INC.

2205-9 ELMWOOD AVE. BUFFALO 23, N. Y.

Ingeniously Designed WISCONSIN-POWERED

Speeds Up Materials Handling

Here is an interesting, effective application of a Model AEN (4½ to 8¼ hp.) Wisconsin Single Cylinder Heavy-Duty Air-Cooled Engine . . . for easy, one man, one hand control of an extension hoist for lifting and dumping loose materials up as high as 80 ft. in one minute, according to the builders, Campbell Equipment Co., Chicago, Ill.

This equipment, shown here pouring concrete, will handle all kinds of loose and bulk materials, delivering them right to the working area for automatic dumping or removal by workmen. Designed for use on construction or storage jobs, the Lad-E-Vator eliminates dangerous swinging buckets and risky reaching operations. Can be used with platform, wheelbarrow or scoop, carrying up to 1000 lbs. per load. Supplied in various types of units, each of which employs a Wisconsin 4-cycle single cylinder heavy-duty air-cooled engine as standard equipment.

The Wisconsin-powered winch is mounted at the base of the hoist, out of the way, behind the Lad-E-Vator where it is fully accessible . . . typifying the adaptability of these compact, rugged engines to fit both the Job and the Equipment. Heavy-Duty design and construction, tapered roller bearings at BOTH ends of the crankshaft, gear-driven high tension OUTSIDE Magneto equipped with Impulse Coupling for quick starts in any weather at low cranking speed . . . these are some of the features that stand back of Wisconsin "MOST H. P. HOURS" of on-the-job service, with minimum servicing.

You can't do better than to specify Wisconsin Air-Cooled Engines for any equipment requiring heavy-duty power within a 3 to 36 hp. range. Our engineering department will be glad to cooperate with you. For further data, write for Bulletin S-164.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 8323-½

Announcing "ADJUSTABLE-STROKE" MIDGET Air-Clamp* CYLINDERS

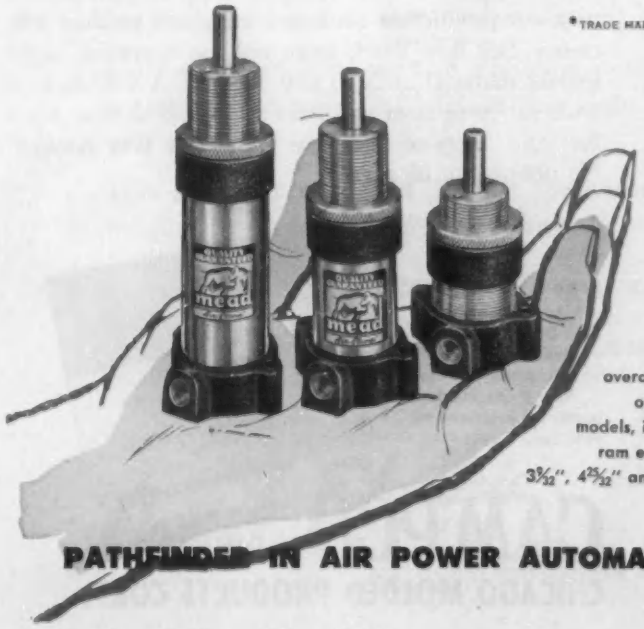
Actual overall length of horizontal models, including ram extension, 3½", 5", 6".

"More per hour, with Mead Air Power"

Now—put pressure where it's wanted instantly and cheaply—with Mead's powerful new midget air cylinders (1" bore, single-acting, spring return.) Stroke is adjustable. Use 'em singly or in groups to move, hold, press or eject small work pieces; to close and open large jigs, forms, fixtures. They'll replace human fingers and mechanical clamps in countless routine jobs.

These new Midget Air Clamp cylinders bear the new Mead label of Guaranteed Quality. Each is guaranteed to give you millions of trouble-free cycles—to be a better value, dollar for dollar, than any comparable cylinder. Try them!

*TRADE MARK



Actual overall height of vertical models, including ram extension, $3\frac{3}{32}$", $4\frac{25}{32}$" and $5\frac{25}{32}$".

PATHFINDER IN AIR POWER AUTOMATION

New! —SAVES TIME!

These six brand-new Air Clamp cylinders with adjustable strokes variable from ½" to 3" can be put to work where longer strokes are needed *and* stroke can be "tuned" to exact length wanted even *after* setup is made! This feature alone multiples their usefulness, saves hours of time designing, laying out special jigs, fixtures.

New! —SAVES AIR!

Stroke change quickly made with spanner wrench (included with cylinder). You can conserve air in large fixtures (where dozens or hundreds of Midget Air Clamp cylinders are used) by using "just enough-no more" stroke. The shorter the stroke, the faster the cycle.

New! —SAVE SPACE & MONEY!

You can shorten stroke to the minimum to save space in cramped quarters. The cylinder "nose" telescopes into barrel reducing stroke and overall length. All this at prices so low you can almost *forget* their modest first-cost. But you'll *remember* the countless man-hours saved—the lessened fatigue of your workers at monotonous jobs—the improved quality and accuracy of their work!

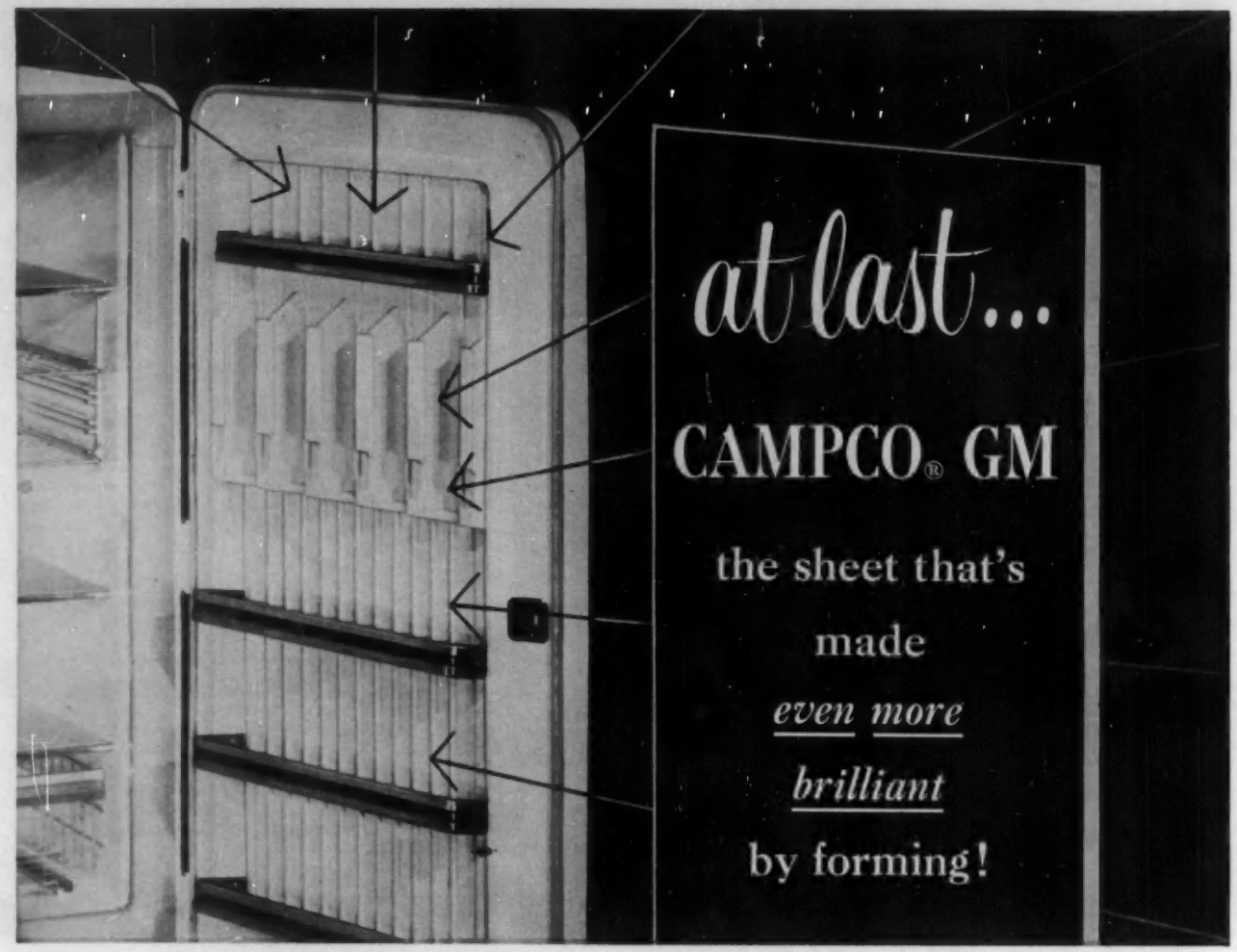
Write Factory or Nearest Mead Representative For Bulletin PE-55

(See Alphabetical Index of Thomas' Register for address, phone number.)

Midget Air Clamps are a Quality-Guaranteed product of

MEAD
SPECIALTIES COMPANY

Dept. PE-55, 4714 N. Knox Ave., CHICAGO 41, ILLINOIS



The doorliner of the new Deepfreeze upright freezer is made of high-gloss, high-impact CAMPCO GM sheet.

CAMPCO GM is the new modified styrene sheet with a high-gloss finish that's "built-in." You can shape this sheet by vacuum forming without dulling its gleaming surface! In fact, forming gives CAMPCO GM *a higher, more lustrous finish* — a brilliance that rivals porcelain enamel.

Yet easy-working CAMPCO is tailor-made for vacuum forming. Intricate designs and inserts present no problem . . . and you can work with simple machines at high speed. Unlimited styling, too! Turn out beautiful display pieces, high-sell packages, glistening panels and linings for kitchen and bathroom equipment and appliances.

New *High-Gloss CAMPCO GM* may be your answer to lower production costs and increased product efficiency. See how much more sell the beautiful, high-impact material adds to any product. Available in a wide range of sizes and colors. Get full details. Send for your copy of the new CAMPCO GM booklet. No obligation, of course.

CAMPCO Division
Chicago Molded Products Corporation

2726 Normandy Ave.,
Chicago 35, Illinois

Please send me your new folder on *High Gloss CAMPCO GM* plastic sheet.

Name_____

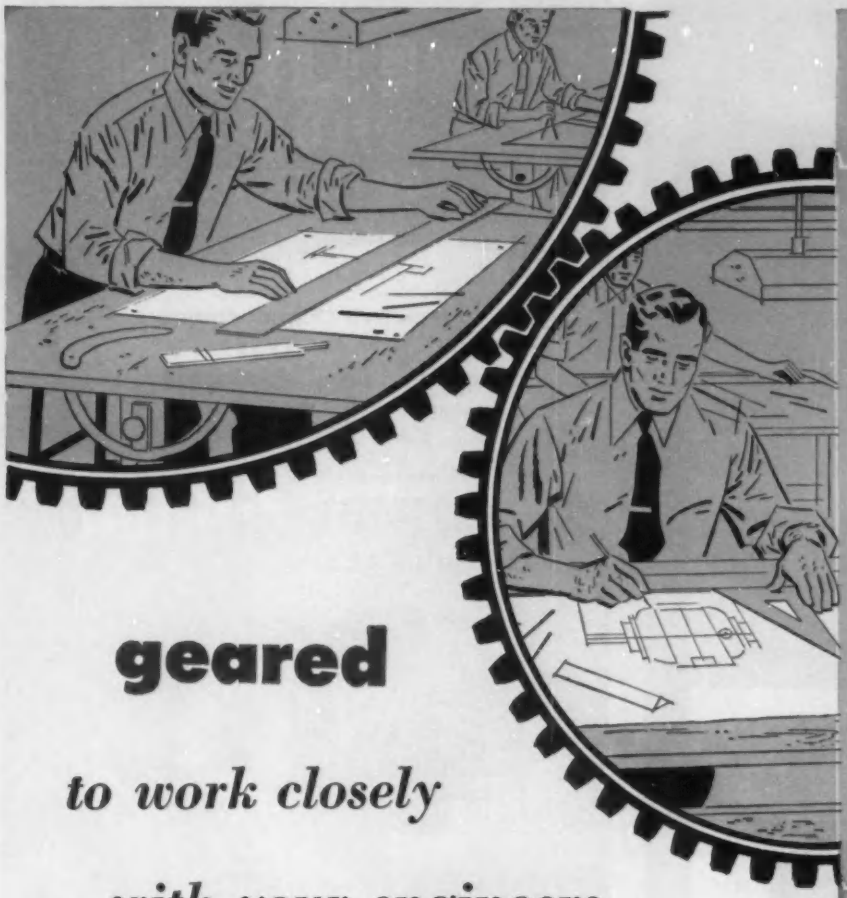
Company_____

Address_____

City_____ Zone_____ State_____

Free — This new folder tells where you can use High Gloss CAMPCO GM . . . how to use it . . . what its properties are . . . how it can build profits for you! Send for your copy today!

CAMPCO DIVISION OF
CHICAGO MOLDED PRODUCTS CORP.



geared

to work closely

with your engineers

on motor-driven products

We work so closely with customers that some consider our facilities a part of their own operations.

Close cooperation of our staff with your purchasing and engineering departments assures the right motor for your product.

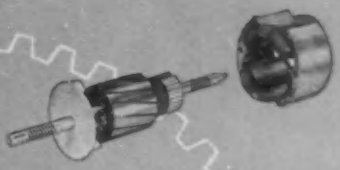
This can mean improved product appearance, reduced weight, greater compactness and lower costs.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

In Canada: Lamb Electric —
Division of Sangamo Company Ltd. — Leaside, Ontario

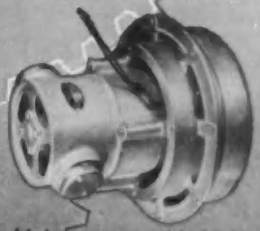
Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

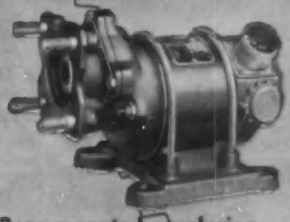


Motor parts for floor polishers, food mixers and other household appliances.

Motor with worm gear reduction for vending machines and similar applications.



A high vacuum with high volume turbine unit for vacuum or blower applications.



Base-mounted, explosion-proof aircraft geared fuel transfer pump motor.

If you are interested in any of the above motors write and we shall be glad to send full information.

SPECIFY G. I.

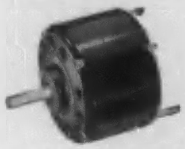
Smooth Power MOTORS

. . . America's Leading Manufacturers Do! . . .

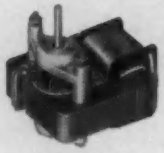
RELY ON GI's quarter of a century of design leadership to produce the best motor for the job.

COUNT ON GI engineering facilities to help you in the development of specific motors for special applications.

DEPEND ON GI production know-how to speed your products down the line profitably, and on time!

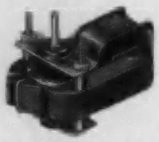


NEW MODEL B
4-pole, 4-coil shaded pole AC Induction Type

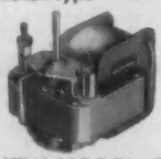


MODEL A
2-pole, shaded pole AC Induction Type

NEW MODEL E
4-pole, shaded pole AC Induction Type



MODEL C
2-pole, shaded pole AC Induction Type



NEW MODEL F
2-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil, shaded pole AC Induction Type

Write for complete specifications and quantity-price quotations!

MODEL O
2-pole Capacitor Reversible Type, AC only (for 6, 12 or 24 volt)

THE GENERAL INDUSTRIES CO.

DEPARTMENT GM • ELYRIA, OHIO

WELDON FLUID METERING PUMPS

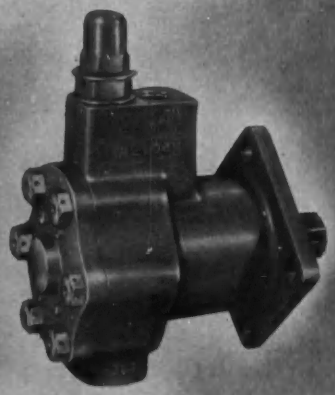
Positive Displacement Rotor Type

For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel

Compact • Light Weight • Small Volume

*STYLE A Single inlet double outlet type aircraft pump

*STYLE F Engine driven fuel pump

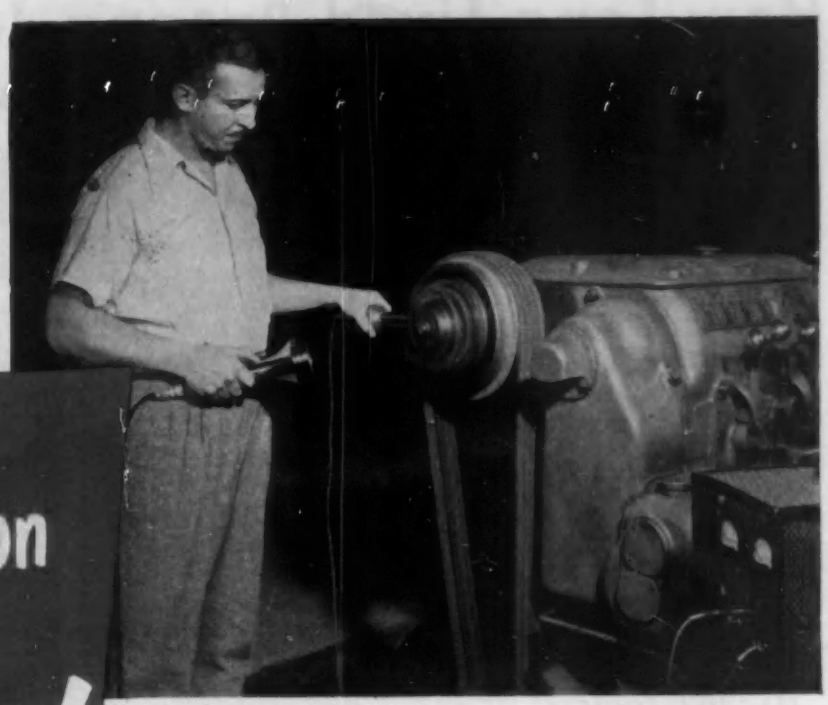


*STYLE C Industrial pump

Send for Weldon Manual and Catalog with detailed specifications and installation drawings.

THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO



Belt Vibration is a Design Problem!

SOLVE IT BY SPECIFYING

VEELOS – the Balanced V-BELT

Read these typical reports on Veelos installations:

"On a water cooler that uses a gear pump with a fan assembly and radiator . . . I was able to *cut vibration 66%*. With Veelos adjustable v-belt, the machine could be shipped . . . when endless belts were used the machine was rejected."

"An oil cooler unit had been a trouble maker with many machines returned. Veelos adjustable v-belt was installed in place of endless belt and the amplitude was lower at every point. The vibration was as much as 76% lower with Veelos."

"On a precision grinder the finished work was not acceptable due to chatter marks. We found by using an electronic vibration analyser that the machine was vibrating .00035" at the spindle when operating with 7B endless v-belts. After balancing the grinding wheel the vibration was reduced to .00015" but the finished work was still not acceptable. I then installed 7B Veelos v-belts and the vibration was down to .00001" and the finished work was now acceptable."

IT WILL PAY YOU to specify Veelos adjustable v-belts because:

- **Veelos gives you efficient, vibrationless, full power delivery.**
- **Veelos gives you complete freedom of design . . . you fit the belt to the drive, not the drive to the belt.**
- **Idlers and pivoted or sliding motor bases are unnecessary.**
- **You can use outboard bearings to advantage. Veelos is installed without dismantling any part of the machine.**

Manheim Manufacturing & Belting Co.
610 Manbel St., Manheim, Pa.

I would like to see vibration reduction demonstrated on the electronic analyser. Have your representative call me for a convenient time.

Name_____

Company_____

Address_____

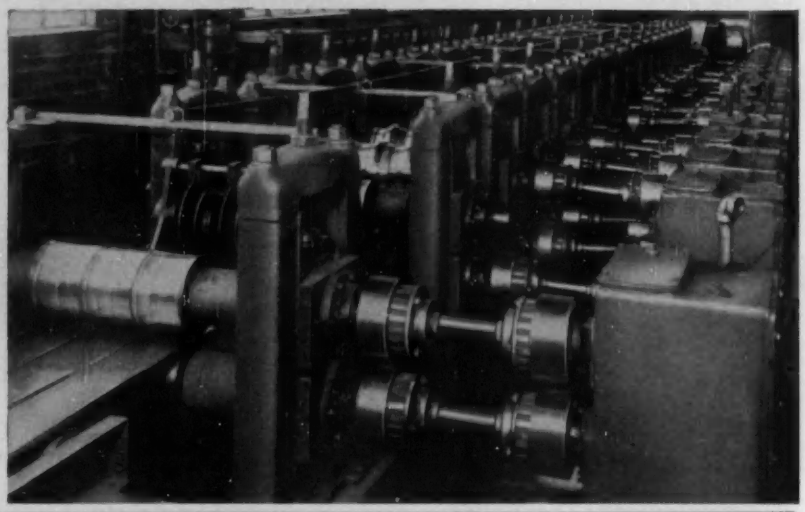
VEELOS
THE BALANCED
LINK V-BELT

Veelos is known as Veelink outside the United States.

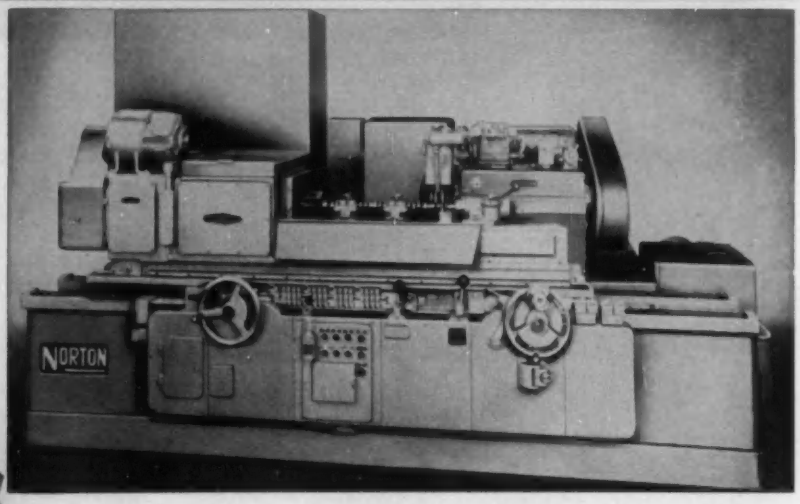
ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

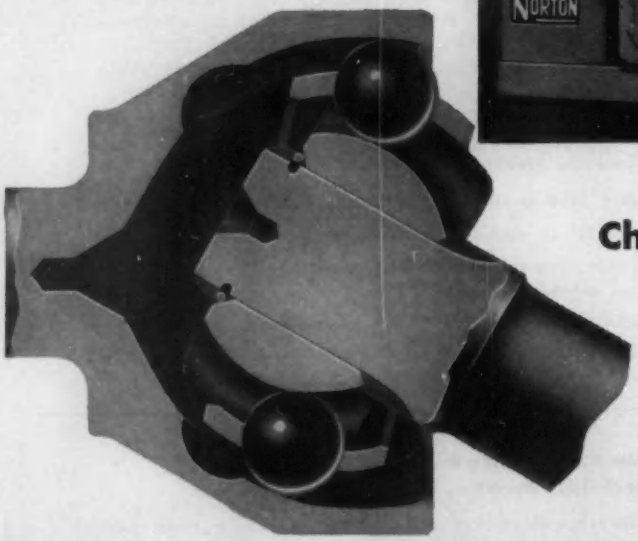
How Long-Lived Rzeppa Joints Stand Up Under Heaviest Drive Loads

ROLLING MILL at Detroit Steel Products Company has licked a severe joint breakage problem with Rzeppa Constant Velocity Universal Joints. Breakage first occurred, just six hours after mill began operation, at the finishing end—where most stresses are applied (foreground). A replacement of the same type also failed—as did other joints along the line as time passed. Five years ago the company began replacing breakages with Rzeppas. *To date not a single Rzeppa has broken.*



MACHINE TOOLS: Norton Company installs Rzeppa Constant Velocity Joints in No. 2 CAM-O-MATIC Grinders for a long life of precision operation. "Rzeppa Joints provide smooth operation, minimum backlash and constant rotating motion regardless of angular motion," says Norton.





Choose the Joint for Your Needs

Rzeppa Constant Velocity Universal Joints are built in both the low angle (to 18°) high speed, disc-type joint (used in applications above), and high angle (to 35°) low speed, bell-type joint. Internal construction of both joints is identical with interchangeable internal parts.

Whatever your application, specify the joint that brings you ruggedness and long life with maximum capacity and true constant rotating motion.

Send for latest catalog.

RZEPPA Constant Velocity **UNIVERSAL JOINTS**
(pronounced "Sheppa")

THE GEAR GRINDING MACHINE CO.
3939 Christopher
Detroit 11, Michigan

CHECK THE ADVANTAGES OF STAINLESS STEEL FASTENERS

✓ for boosting product quality!

Where appearance and performance call for quality parts, don't overlook the advantages of stainless steel fasteners. Take the illustrated E. W. Ferry fasteners, for example. They're priced right in line with quality fasteners of other materials. Yet they offer all the extra qualities stainless steel brings to any part — high tensile strength . . . attractive, rust-resisting finish . . . and remarkable resistance to heat and corrosion. In almost any application they outlast, many times over, fasteners of nonresistant or plated metal. They cut maintenance costs, too. For even after years of service, disassembling rust-free stainless fasteners is always a fast, easy operation.

✓ for reducing production costs!

The hardness of stainless steel fasteners results in substantial savings on the assembly line. Work is faster, results are better — simply because stainless screw-heads are less apt to burr and nick. This means major savings, for even a slipping screwdriver can seriously damage both the screw and the parts being assembled. Stainless steel fasteners cut tooling costs, too. For they are now available in practically every size and description.

Crucible now offers stainless fastener wire in all diameters . . . in suitable tempers . . . in a variety of finishes, including bright and several metallic and nonmetallic coatings . . . in all standard grades. For prompt delivery of the stainless steel wire you need — or for your free copy of Crucible's new, 32-page catalog "Rezistal Stainless Steel Wire" — call or write to *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

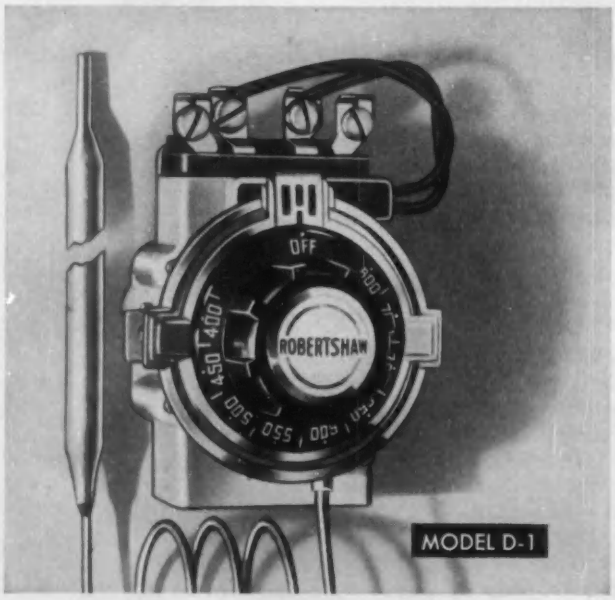
CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

NEW mercury-actuated thermostat for DEPENDABLE TEMPERATURE CONTROL UP TO 800°F

For surface or immersion operation, the new mercury-actuated Robertshaw® Model D-1 thermostat provides close, accurate temperature control to 800°F. Requiring no separate "off" switch, its mechanical over-center snap-action make and break mechanism is actuated by a mercury-filled hydraulic thermostatic element. Contacts and bridges are of fine silver, levers and supports of case-hardened steel. Maximum sensitivity and instant actuation of the snap-switch within closely-maintained temperatures. Other models include reverse and direct-acting types; single and double pole; single and double throw; single and double circuits; with and without limit switches. Write today for details.

DOUBLE POLE SINGLE THROW DIRECT-ACTING THERMOSTAT MERCURY-ACTUATED. TEMPERATURE RANGE TO 800°F. RATING 35 AMPS., 125V AC; 25 A, 250V AC.



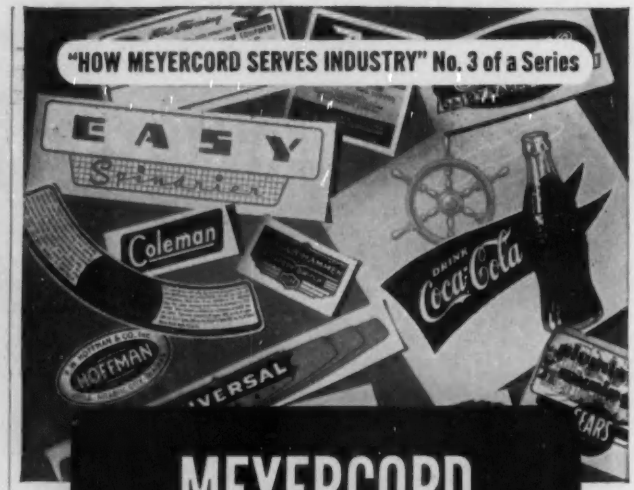
MR. CONTROLS

Robertshaw-Fulton CONTROLS COMPANY

Robertshaw Thermostat Division, Youngwood, Pennsylvania

Robertshaw-Fulton Controls (Canada) Ltd., Toronto

(Largest manufacturer of thermostats for commercial and industrial applications.)



MEYERCORD *Nameplate* DECALS Help SELL Your Product

Your trademark and brand names are symbols of consistent high product quality. When prominently and appealingly displayed on your products, they are confidence-building assets that improve competitive position in today's brand-conscious market.

Meyercord Nameplate Decals identify and help move all types of products faster across your dealer's counter and out of his stockrooms—with trademarks that are attractive, colorful, uniform, legible, and durable. Applied speedily and economically on your present assembly-line . . . for long or short runs.

Our special staff of skilled artists, photographers, typographers, color experts, and merchandising-advertising counsellors are ready to help you establish a strong selling identification for your product . . . at minimum cost per unit. This is another of Meyercord's complete and continuous services to industry. Let a highly-trained Meyercord Decal engineer show you how to add sales appeal to your product, while cutting nameplate costs.

FREE! "MARK-IT" MANUAL OF DECAL NAMEPLATES

Send today, on your company letterhead, for this valuable full-color guide to every industrial problem in marking, identification, instruction, and information. Gives you hundreds of new ideas for the application of decals to your products.

THE MEYERCORD CO.

World's Largest Decalcomania Manufacturers

DEPT. G-318, 5323 WEST LAKE STREET • CHICAGO 44, ILLINOIS

ANOTHER UNUSUAL PROBLEM SOLVED BY LORD

LORD MOUNTINGS TAKE THE SHOCK LOSS OUT OF SHIPPING!

Why accept costly shipping damage as a "necessary evil" when your equipment can be shipped safely with LORD re-usable Shock and Vibration Control Shipping Mountings?

Available in standard models or specifically designed for extraordinary problems, these bonded-rubber mountings have practically eliminated costly shipping damage to such fragile units as electronic tubes and instruments, business machines, and other easily-damaged equipment.

LORD mountings effectively reduce shock damage with the proved combination of specially designed, shock-absorbing rubber bonded to metal for structural strength and mounting accuracy.

Whether your "shipping-shock" problems can be solved with standard LORD mountings or will require a special design, LORD engineers will gladly show you how LORD mountings can insure delivery of your equipment without damage to its accuracy or sensitivity.

Remember—LORD Products are engineered to provide the best in shock and vibration control! Contact the LORD Field Engineer nearest you, or.

LORD MANUFACTURING COMPANY, ERIE, PA.

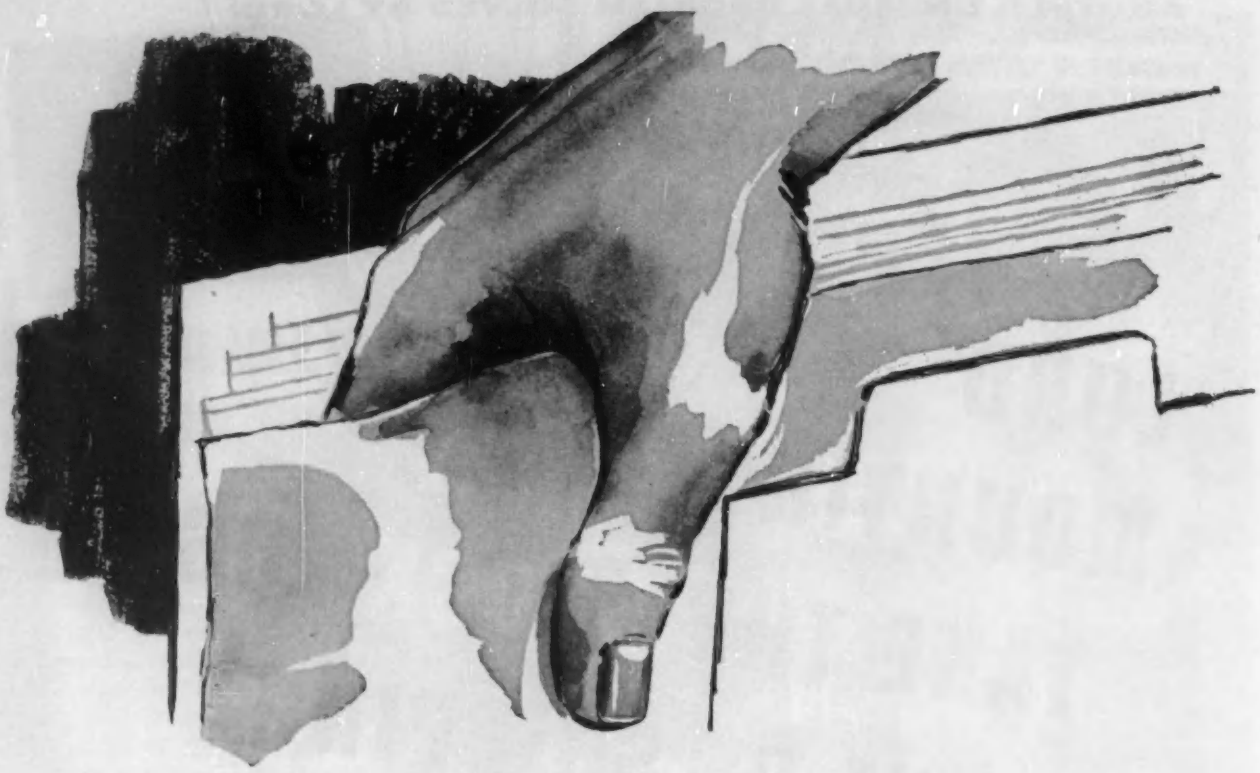
LOS ANGELES, CAL. HOllywood 4-7593 | DALLAS, TEXAS Riverside 3392 | DETROIT, MICH. TRinity 4-2060 | NEW YORK, N. Y. Circle 7-3326

PHILADELPHIA, PENNA. LOcust 4-0147 | DAYTON, OHIO Michigan 8871 | CHICAGO, ILL. Michigan 2-6010 | CLEVELAND, OHIO SUperior 1-3242

"In Canada—Railway & Power Engineering Corporation Limited"

LORD BONDED RUBBER

DESIGNERS AND PRODUCERS OF BONDED RUBBER PRODUCTS SINCE 1924

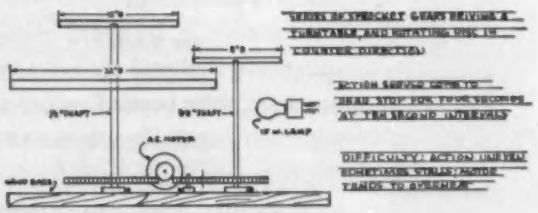


filed . . . . because you could not find a motor of correct specifications to power your brain child

You are sure your idea is sound. You have checked every phase of its operation on paper. Your mock-up looked sensational. Yet the motors you tried were not satisfactory. The machine did not come up to expectations. You put it aside, hoping some day to locate the trouble.

The answer . . . may be in the gearing, the bearings, the load, the motor speed, the motor torque rating . . . or an excess power demand that could be solved by simple redesign to reduce friction and restore balance.

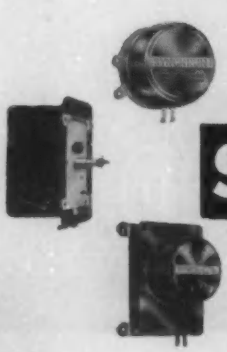
All good ideas should be given a second chance. Take that "should-have-worked" idea out of your file. And if you believe it failed because of an inadequate power unit, give us the facts. Just draw a simple diagram, like this:



Give this information to your local SYNCHRON Representative, or mail it to the factory. Your particular problem will be referred to our carefully guarded research department for confidential analysis and reply.

FACTORY REPRESENTATIVES:

Wesley & Fromm, 5254 W. Madison St., Chicago, Ill.
R. H. Winslow & Associates, 123 E. 37th St., New York, N. Y.



"Workhorse of the Industry"

SYNCHRON

SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, AND MAGNA-TORC D.C. MOTORS

HANSEN MANUFACTURING CO., INC. PRINCETON 5, INDIANA

Established 1907

TO BENEFIT USERS OF ALL SANDVIK PRODUCTS

The new Sandvik building provides modern, expanded facilities for the *administrative, production* and *Eastern Warehouse* operations of the main company and all divisions, including:

SANDVIK-COROMANT
Carbide Tipped Tools, Blanks and Inserts, Milling and Combination Cutters.

SANDSTEEL SPRING
Power springs for watches, instruments, office machines and other industrial uses.

SANDVIK STEEL BELT CONVEYORS
Cold rolled Carbon and Stainless Steel Belt Conveyors for Material Handling and Processing.

SANDVIK SAW & TOOL
High Quality Swedish Hardware, Tools and Specialties.

Works: Sandviken, Sweden • Hellefors, Sweden

Sandvik Quality Steels

SS-107

For applications which require HIGH FATIGUE LIFE, FINE SURFACE FINISH, ACCURATE & UNIFORM GAUGE specify SANDVIK cold rolled specialty strip steels.

You can get Sandvik strip steels:

- **In special analyses for specific applications.**
- **Precision-rolled in thicknesses to fit your requirements.**
- **In straight carbon and alloy grades.**
- **Annealed, unannealed or hardened and tempered.**
- **Polished bright, yellow or blue.**
- **With square, round or dressed edges.**
- **Wide range of sizes in stock—**
  —or slit to your specifications

Ask your nearest Sandvik office for further information or technical assistance.

Sandvik Swedish Specialty Strip Steels are used for Textile Machine Parts such as sinkers, needles, etc. • Band Saws (metal, wood and butcher) • Camera Shutters • Clock and Watch Springs • Compressor Valves • Doctor Blades • Feeler Gauges • Knives such as cigarette knives, surgical, etc. • Razor Blades • Shock Absorbers • A Wide Variety of Springs • Trowels • Reeds: Vibrator, Textile, etc. • Piston Ring Segment and Expanders • and many other applications.

SANDVIK STEEL, INC.
1702 NEVINS ROAD, FAIR LAWN, NEW JERSEY
Tel. Fair Lawn 4-6200 • In New York City: WAtkins 9-7180
Warehouses: Fair Lawn, N. J. • Cleveland • Los Angeles
Branch Offices: 230 N. Michigan Ave., Chicago 1, Ill., FRanklin 2-5638
1736 Columbus Road, Cleveland 13, Ohio, CHerry 1-2303
3609 E. Olympic Blvd., Los Angeles 23, Cal., ANgelus 3-6761
IN CANADA:
SANDVIK CANADIAN LTD., P.O. Drawer 430, Station O, Montreal 9, P.Q.

Do you have a TOUGH CORROSION-RESISTANT CASTING PROBLEM?

that needs a solution for your product design?

Problem—Do you require quality corrosion-resistant castings that: are also resistant to high fluctuating temperatures; machine freely; require a highly polished surface; are true to pattern; stand high pressures and high loads; are stabilized; are of large size, small size, intricate shapes; have high resistance to galling or seizing; are non-magnetic?

Solution—Consult with Waukesha—specialists in quality corrosion-resistant castings to meet the design requirements of the leading products in many industries.

Why Waukesha—Experience: Waukesha has over forty years' broad experience in providing quality-controlled, corrosion-resistant castings to industry. This hard-earned know-how and specialized craftsmanship is at your disposal. **Research:** A modern laboratory guarantees castings metallurgically engineered to your specifications . . . **created metals** to fit the job . . . precise **custom castings** to help improve your products. **Facilities:** Waukesha can supply your production casting needs on schedule.

We Suggest—that you write, today, for a casting quotation from your blueprints or engineering counsel on your casting design. Informative literature available on request.

Waukesha Foundry Company, 5503 Lincoln Avenue, Waukesha, Wisconsin

Waukesha Corrosion-Resistant Casting: Pump impeller for the chemical and processing industries. Metallurgical control of every production step guarantees you quality precision castings.

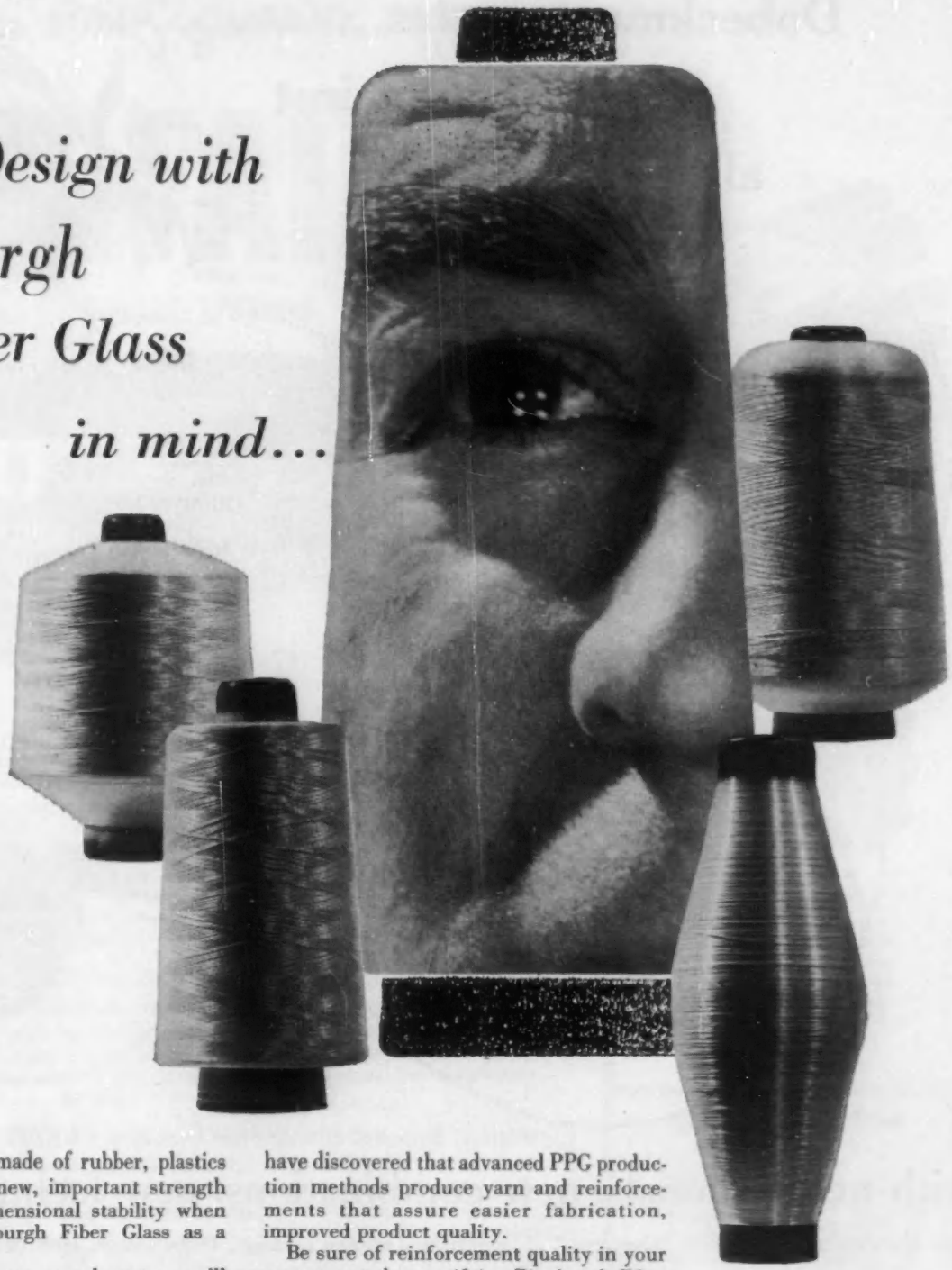
The Waukesha metallurgical laboratory is available for research on your casting needs.

Waukesha Foundry Company

WAUKESHA, WISCONSIN

WAUKESHA: SPECIALISTS IN CORROSION-RESISTANT CASTINGS FOR ALL INDUSTRIES

Design with Pittsburgh Fiber Glass in mind...



Component parts made of rubber, plastics or paper take on new, important strength and additional dimensional stability when you specify Pittsburgh Fiber Glass as a reinforcement.

In housing and structural parts, you'll add excellent dielectric strength when reinforcing cloth containing Pittsburgh Fiber Glass is specified for laminates used in making such parts.

Yes, the design trend is to fiber glass reinforcements—and specifically, to Pittsburgh Fiber Glass, because of its exceptional quality. Manufacturers and molders alike have discovered that advanced PPG production methods produce yarn and reinforcements that assure easier fabrication, improved product quality.

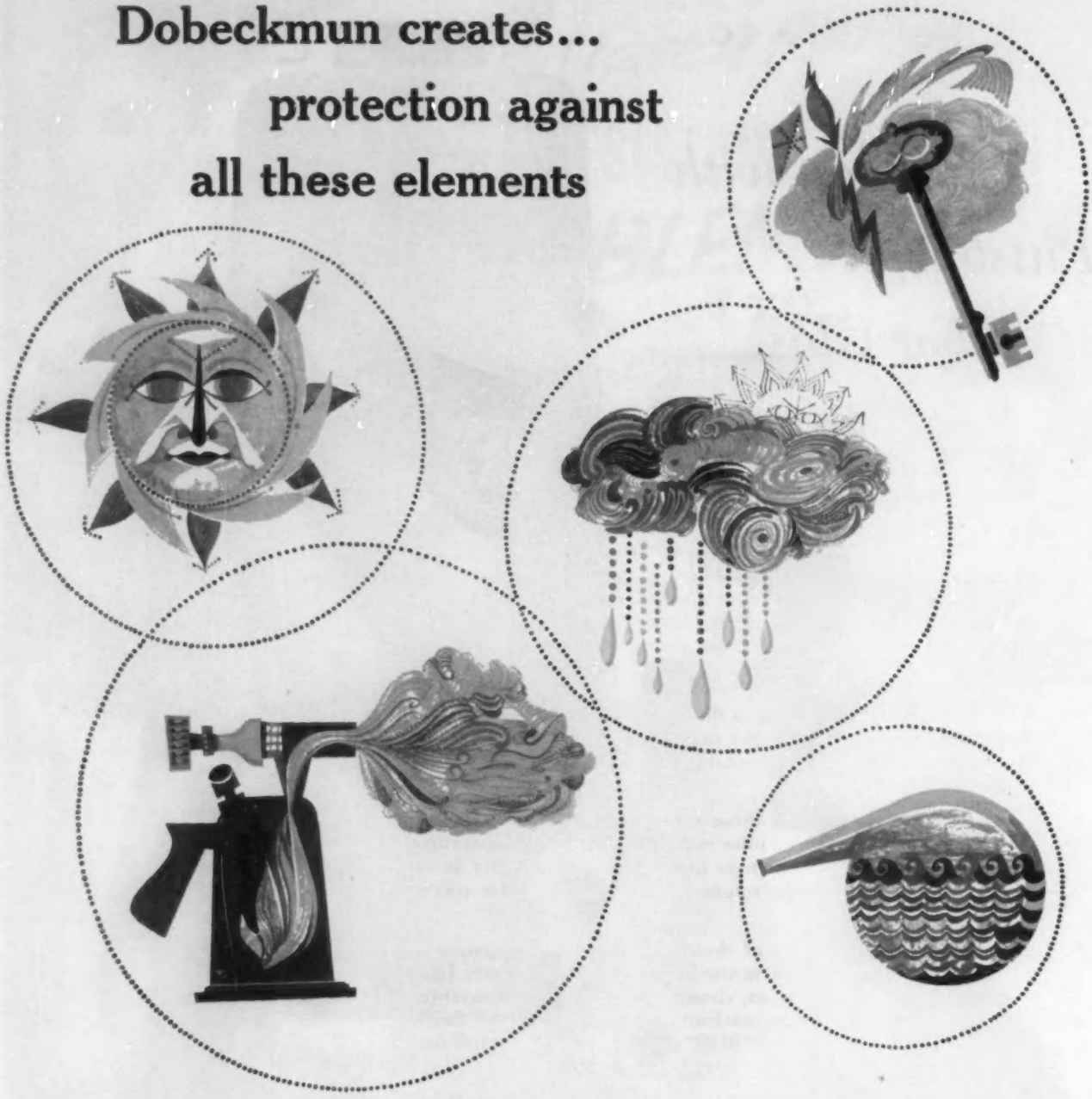
Be sure of reinforcement quality in your components by specifying Pittsburgh Fiber Glass. For complete information and technical staff assistance, write our executive offices or sales offices in Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Los Angeles, New York, Philadelphia or St. Louis. Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pennsylvania.

FIBER GLASS PG

PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

Dobeckmun creates... protection against all these elements



with new materials, new combinations, new techniques!

The ancients spoke of four "elements" . . . earth, water, fire and air. Dobeckmun creates materials that protect against all four . . . and light and loss of electricity as well. We're specialists in laminating, slitting, plasticoating and printing flexible materials for everything from potato bags that double as supermarket salesmen to super-thin insulating tapes of astounding dielectric strength. If you need lightweight industrial materials that will do heavy duty, call on Dobeckmun. If we don't have what you want, we'll create it.

Dobeckmun Company, Cleveland 1, Ohio · Berkeley 10, California

Laminating . . . Plastic coating . . . Slitting . . . Printing of flexible papers, foils, films and cloth

Write today for complete catalog and samples to P. O. Box 6417, Cleveland

TUTHILL PUMP COMPANY EXPERIENCES...

"NO FAILURES

SINCE USING

SAVES MONEY, TOO!"

Tuthill knows the rotor is the heart of their pump. Quality cannot be compromised. For more than 10 years, Tuthill has used STRESSPROOF for rotors (replacing heat-treated alloy steel) without a failure!

Strength is required in these rotors to transmit the power through the shaft to the idler gear. Extremely high operating speeds mean the rotors must be straight. Wearability is an absolute necessity if the rotors are to stand up under severe operating conditions.

STRESSPROOF has all of these qualities. In addition, it is readily machinable. Its in-the-bar strength eliminates heat treating with its distortion, cleaning and subsequent machining problems. No rough machining, heat treating and finish machining with STRESSPROOF. The rotors are finish-machined from the bar.

STRESSPROOF's minimum warpage eliminates all straightening operations in this case. Its wearability keeps the rotor running year after year. It also provides real savings in both material and manufacturing costs.

STRESSPROOF makes a better part at a lower cost.

Tuthill Model L Series mechanically sealed pumps are used in lubricating, hydraulic, transfer and burning oil service. Capacities range from ½ to 6 g.p.m. at pressures up to 600 p.s.i. The rotors for these dependable industrial pumps are made from La Salle STRESSPROOF.

WRITE TODAY FOR

helpful data bulletin No. 15... "Improve Quality — Cut Costs"

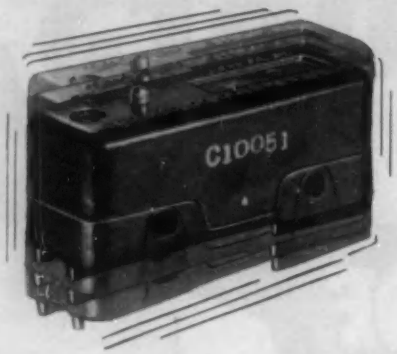
AVAILABLE FROM LEADING STEEL DISTRIBUTORS COAST-TO-COAST

La Salle STEEL CO.

1430 150th Street, Hammond, Indiana

MANUFACTURERS OF AMERICA'S MOST COMPLETE LINE OF QUALITY COLD-FINISHED STEEL BARS

NEW Acro Hi-G *SNAP ACTION* Switch



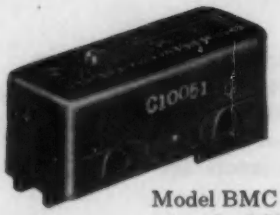
You Can Shake It and Not Break It!

. . . Break The Current, That Is!

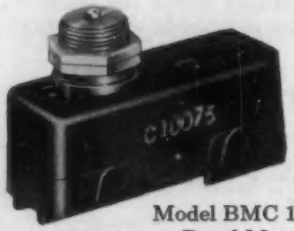
Even at 15 G's from 0 to 500 cps

No flutter on contact traverse at *any* rate of actuation

- Made to MIL Standards
- Good Repeatability
- High Rating at 28 Volts, D.C.
- Built for Long Life



Model BMC 10051
Standard Mount



Model BMC 10075
Panel Mount

In making the Hi-G switch available, Acro engineers have solved a specific problem for the aircraft and machine tool industries. You can use them with confidence wherever there is need for a miniature snap action pressure or limit switch that actuates slowly and is immune to vibration. Complete details are given in Data Sheet C-1. Write for it today.

ACRO MANUFACTURING COMPANY

ACRO SWITCH DIVISION

COLUMBUS 16, OHIO

Plants at Columbus and Hillsboro, Ohio

REPRESENTATIVES IN ALL PRINCIPAL CITIES

HOW TO TAP THE BRAINS OF *OTHER* EXPERTS . .

AND FIND THE IDEA *YOU* WANT

Just look in your 1955 Annual HANDBOOK of *Product Design*. And if the idea is not there, chances are it, and much more of the product-engineering data you need, is in the '54 and '53 HANDBOOKS.

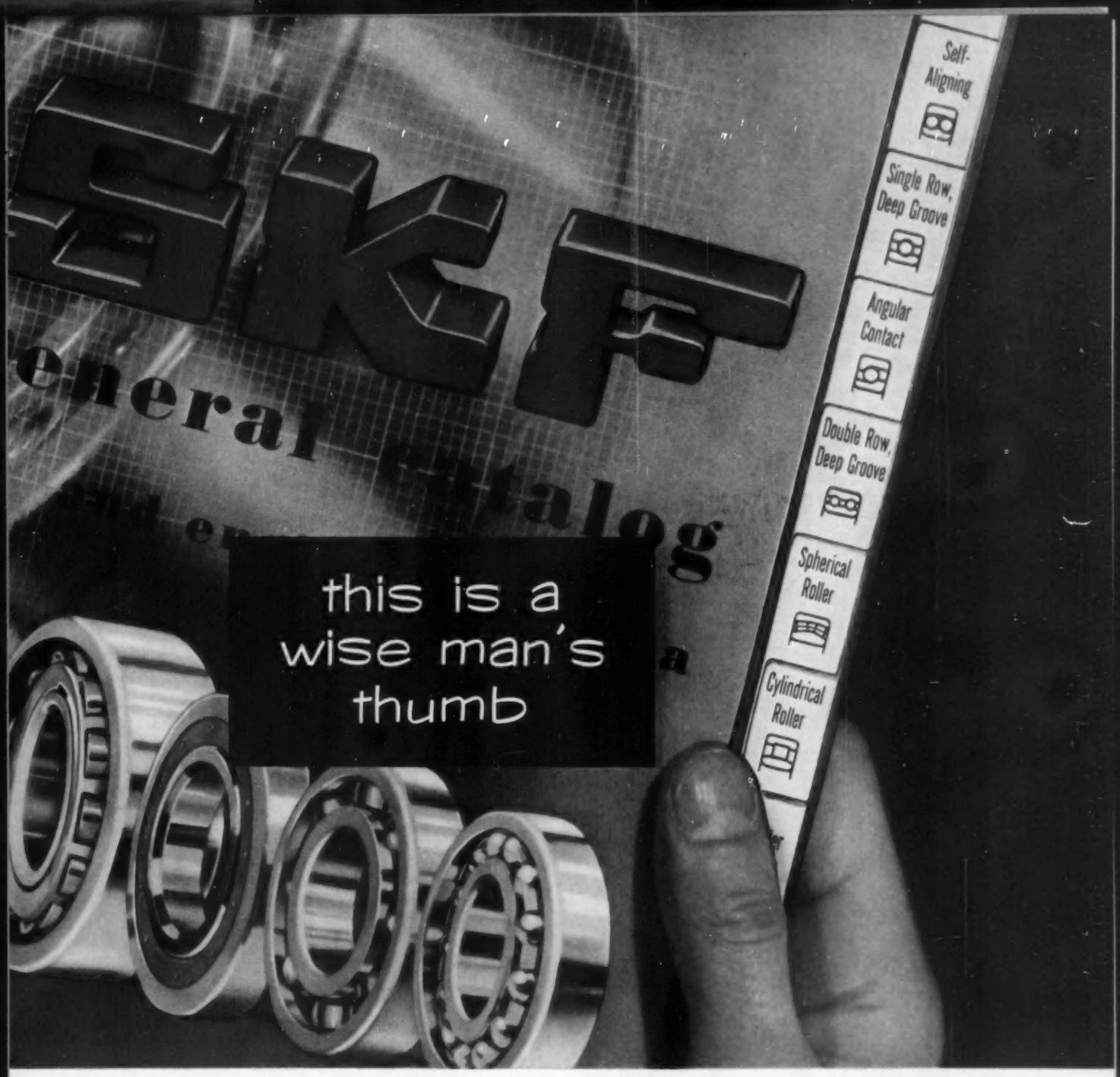
For example, in all three of these invaluable HANDBOOK issues you'll find the most significant information of its year on:

- General Engineering
- Metals and Alloys
- Non-Metallic Materials and Finishes
- Fabrication and Production Processes
- Power Transmission
- Mechanical Parts and Design Analysis
- Fastening and Joining
- Motors, Engines and Controls
- Electrical and Electronic Components
- Hydraulic and Pneumatic Equipment

And that's not all. Following each of these ten editorial sections you'll find hundreds of informative advertisements on products and services with which you can make your ideas into profitable design realities.

Product Engineering

McGraw-Hill Building, New York 36, N. Y.



The Design Engineer wants facts about bearings and, wisely, he starts his search in a catalog that covers both ball *and* roller bearings – the SKF catalog.

He knows some other things . . .

- that SKF's field engineering staff, second to none in breadth of experience, has a man on call in *his area* . . .
- that SKF's home office engineering staff has men who specialize on bearing applications in *his industry* . . .
- that SKF's expanded laboratory can, if needed, perform special experimental work on *his problem* . . .

SKF – serving *all* industries – invests most heavily in bearing application service. By putting the right bearing in the right place, this service can help your product gain a competitive edge—through lower cost, longer life, reduced maintenance, and improved performance.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—manufacturers of **SKF** *and* HESS-BRIGHT® *bearings.*

7601

SKF®

BALL AND ROLLER BEARINGS

© 1955 SKF Industries, Inc.

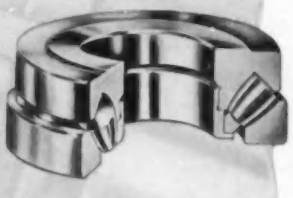
Bearings the wise man buys

SKF EXCLUSIVE

For heavy duty service, the wise designer specifies this *improved* (Type "C") *Spherical Roller Bearing*. Only SKF makes it. Size for size, it provides up to 50% more capacity than other spherical roller bearings – vastly longer life for given radial and thrust load conditions.

SKF THRUST LOAD CARRIER

SKF's *Spherical Roller Thrust Bearing* is the wise designer's answer where the problem is to support heavy thrust loads, or combined loads which are predominantly thrust, on vertical or horizontal shafts. The only roller thrust bearing that is inherently self-aligning.



SKF STEELWORKER

For roll necks (and many other applications, too) the wise designer specifies SKF Multi-Row Cylindrical Roller Bearing, a design which provides the utmost in radial rigidity. In the larger sizes, SKF's hydraulic system makes mounting and dismounting easy.

SKF PROVED AND IMPROVED

The wise designer has long specified the proven SKF *Triple-Seal "SAF" Pillow Block*. The "SAF" is easy to install and inspect; effectively seals out dirt while retaining lubricant; bearing self-aligns. Now, to provide increased life and capacity, SKF makes the "SAF" available with the *improved* (Type "C") *Spherical Roller Bearing*. As a further improvement, the "SAF" can now be obtained with either cast iron or steel housing.

Let nearby SKF Field Engineers help you put the right bearing in the right place in your designs.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.— *manufacturers of* **SKF** and HESS-BRIGHT® *bearings.*

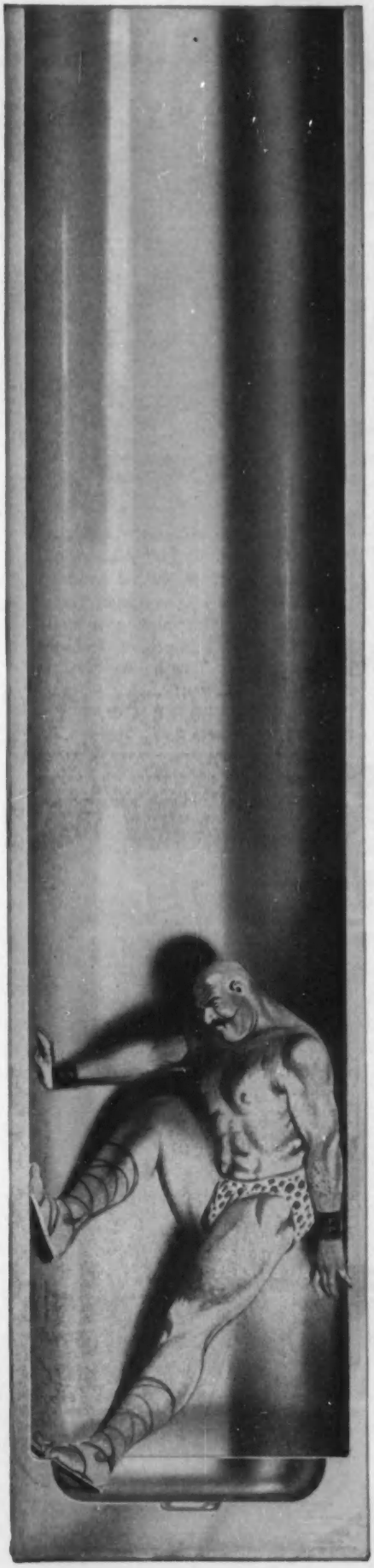
7601 A
FORM 411

SKF®

BALL AND ROLLER BEARINGS

© 1955 SKF Industries, Inc.

See idea for design engineers on other side.



Could you wrap up 3000 psi a BETTER way ?

• The Mullins *Koldflo** Process *cold extrudes* this accumulator shell, which operates at 3000 psi, and withstands 12,000 psi burst pressure. For high-pressure service in hydraulic starting systems, this one-piece design is ideal. It eliminates assembly of forgings and tubing required with conventional designs, eliminates an O-ring seal as well.

Extruded with integral end to finished dimensions, *Koldflo* accumulator shells can wrap up *your* pressure problems better—and at less cost! If you require precision cylindrical steel parts in high volume, give us your specifications, and quantity required. We'll be glad to show you how *Koldflo* can turn your new designs into new and better products.

Mullins Koldflo extrudes this 4¾" diameter accumulator shell in one piece. These extrusions can be furnished in a variety of shapes and sizes and with a choice of mechanical properties. Tolerances are extremely close as made. Surface finish measures 60 RMS or better, depending on shape.

"How would you tool-up to make an egg?" For copy of informative new booklet, write Koldflo Division, Dept. J-5 Mullins Manufacturing Corporation, Warren, Ohio.

*Trade-Mark Reg. U.S. Pat. Off.

DISTRICT SALES ENGINEERING OFFICES

NEW YORK
500 Fifth Avenue
Phone: Pennsylvania 6-2773

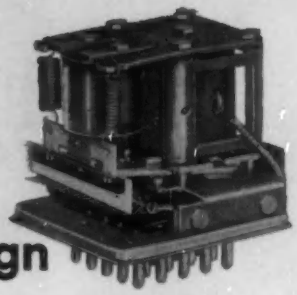
DETROIT
18268 James Couzens Highway
Phone: Diamond 1-1490

CHICAGO
332 South Michigan Avenue
Phone: Harrison 7-3725

Koldflo
DIVISION
MULLINS MANUFACTURING CORPORATION
Warren, Ohio

Phone: 2-1166

Why REGOHM Regulators are preferred by design engineers for these applications

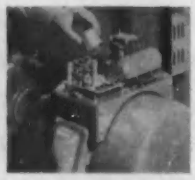


Selenium Rectifier Power Supplies

REGOHM regulates voltage of this selenium rectifier power supply used in testing aircraft equipment. Despite widely varying input voltage of the equipment, stability problems are solved by REGOHM's built-in, thoroughly reliable dashpot. No anti-hunt networks are required. System design is simplified.

Aircraft Inverters

REGOHM controls the frequency of the aircraft inverter that powers the B-47's automatic fire control system. It withstands severe shock, vibration, temperature ranges from −65°C to +71°C and 50,000 foot altitudes. Its performance cannot be matched by any equipment of comparable size, weight or cost.



Motor Generator Sets

REGOHM means close-tolerance voltage control on motor generator sets up to 40KW that power machine tools. The regulator's fast speed of response saves wear and tear when tools are started and stopped. REGOHM's long life is measured in years. Its plug-in feature simplifies replacement by unskilled personnel.

Infrared Spectrometers

REGOHM controls current to assure constant radiation from infrared source, enhancing the accuracy of this infrared spectrometer. The regulator's characteristics, compactness and reliability simplify system design. It replaces heavier, more expensive and complex, but less accurate, equipment.

Check this list:

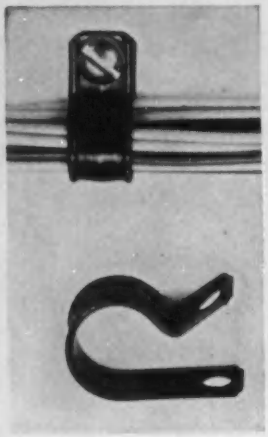
- ☐ Battery Chargers
- ☐ Airborne Equipment
- ☐ Portable and Stationary Generators
- ☐ Marine Radar
- ☐ Underwater Sound Systems
- ☐ Telephone Central Station Equipment
- ☐ Railroad Signal Systems
- ☐ Refrigeration Equipment
- ☐ Filament Regulation
- ☐ Computers
- ☐ Airport Lighting Systems
- ☐ Inverters
- ☐ Railroad Car Lighting Systems
- ☐ Locomotive Braking Systems
- ☐ Wire and Radio Communication Systems
- ☐ Air Navigational Systems
- ☐ Guided Missiles
- ☐ Oil Field Exploration Systems
- ☐ Signal and Alarm Systems
- ☐ Instrumentation Systems
- ☐ Magnetic Clutches
- ☐ Tension Control Equipment
- ☐ Saturable Reactors

If you find your equipment or system listed, or have a problem in other fields, contact Electric Regulator Corporation, 130 Pearl Street, Norwalk, Conn. Our engineers will help you design required circuitry... recommend the proper REGOHM type... calculate the resistor network... suggest design modifications for optimum performance... analyze final designs... assist in testing pre-production models... service your requirements. Write us today.

REGOHM

Electric Regulator Corporation
Norwalk, Connecticut Temple 8-4311

NyGrip ALL NYLON CABLE CLIPS



- Type 4 (shown above full size) holds 1/16" to 1/2" dia. wiring, tubing, etc. • Prices reduced
- Also black nylon screws, nuts, perforated strapping now available • Non-corrosive • Light weight • Tough • Flexible

— Write —

WECKESSER CO.
5265 N. Avondale Ave., Chicago, Ill.

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES

Read by Sight, Sound or Feel.

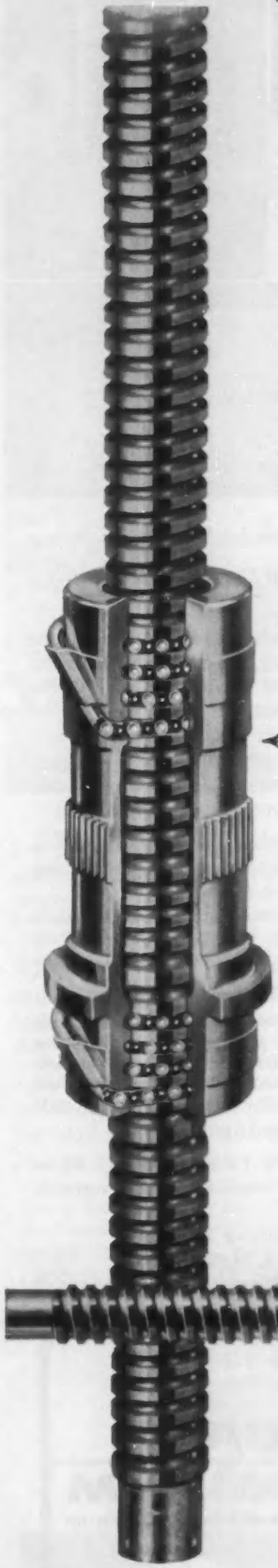
- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch grams... inch ounces... inch pounds ...foot pounds (All sizes from 0-6000 ft. lbs.)

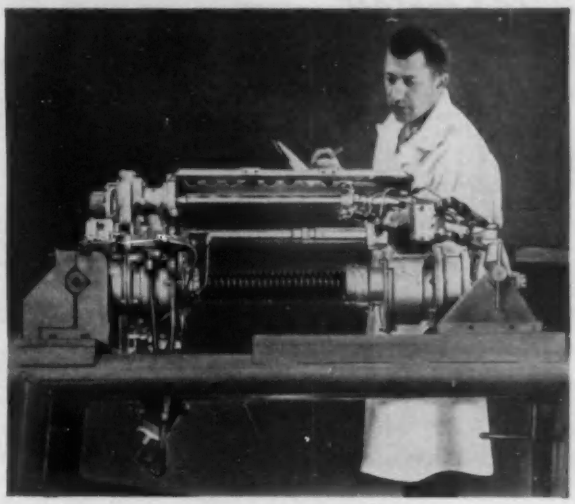
Every manufacturer, design and production man should have this valuable data. Sent upon request.

PA STURTEVANT CO
ADDISON (QUALITY) ILLINOIS

VARD · · · FIRST IN MECHANICAL ACTUATION



This complete Boeing B-52 Stabilizer Trim Actuator incorporates a 2.87″ P. D. Vard ball nut and screw which is made from 9315 steel carburized to Rc 58 and utilizes multiple circuits of alternate spacer and load balls. The unit also contains 3 gear drives, 2 hydraulic motors, 2 Acme screws and electric and hydraulic actuators.

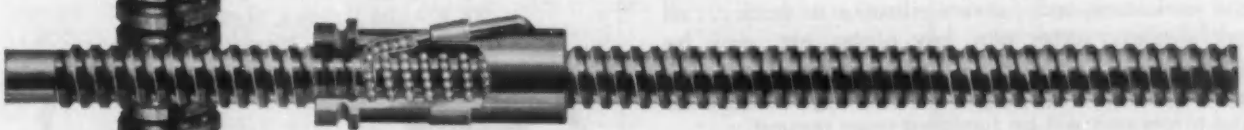


IN HANDLING YOUR SPECIFIC PROBLEM . . .

It is possible that one or more of the many types of ball screws now in production at Vard can satisfy your immediate needs.
Our model shop is also in a position to deliver custom units promptly.

Vard engineers will analyze your ball screw requirements to determine the advisability of single or multiple ball circuits. Either of these options may require all load balls or alternate spacer balls. You may be sure that the combination indicated by our analysis will best meet your needs and will be produced by the finest facilities available.

Resident Sales Engineers:
New York City
Dayton, Ohio



VARD

2981 East Colorado Street
Pasadena 8, California

HUGLOCK

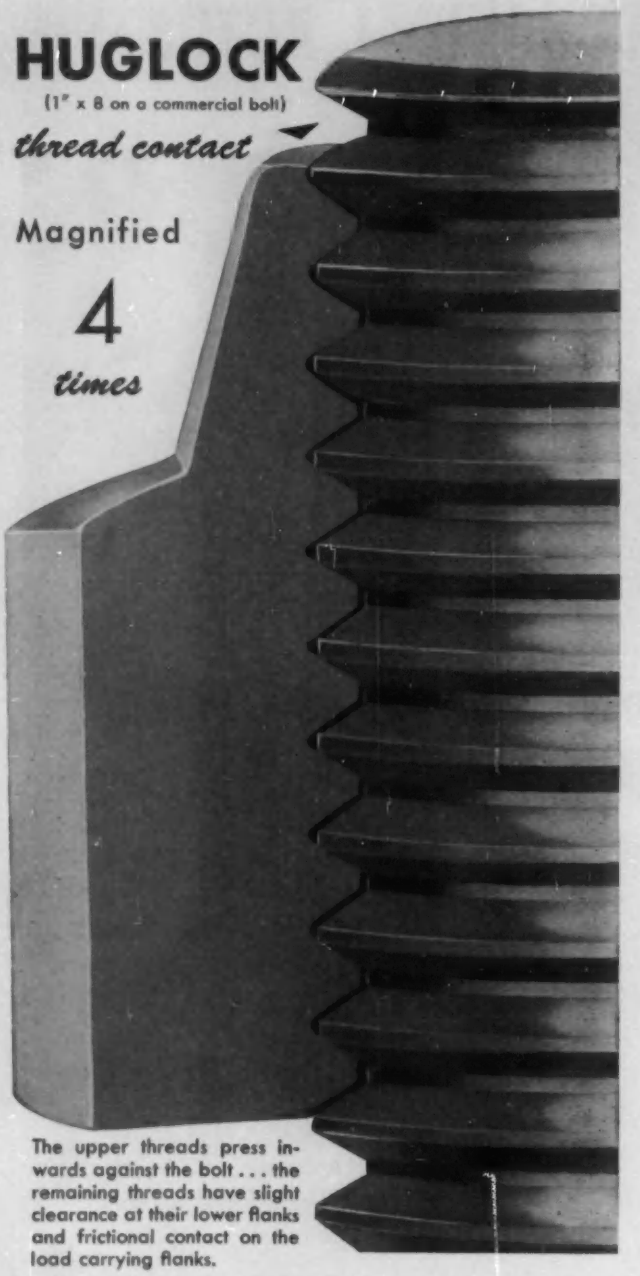
(1" x 8 on a commercial bolt)

thread contact

Magnified

4

times



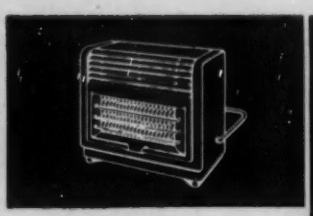
The upper threads press inwards against the bolt . . . the remaining threads have slight clearance at their lower flanks and frictional contact on the load carrying flanks.

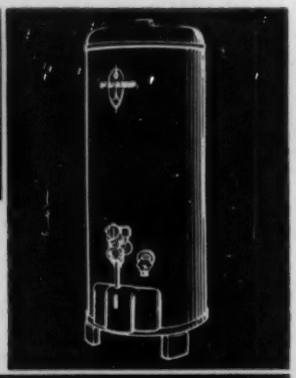
"HUGLOCK" maintains its locking action through repeated removals . . . locks to the bolt, whether the nut is seated or unseated . . . eliminates axial thread play, which tends to make nuts creep from their seat and work loose, under severe vibration or shock . . . all lock washers, cotter pins, key plates, etc., may be eliminated . . . The "HUGLOCK" section of our new catalog, contains 24 pages, includes engineering data and prices and will be furnished upon request.

NATIONAL MACHINE PRODUCTS COMPANY

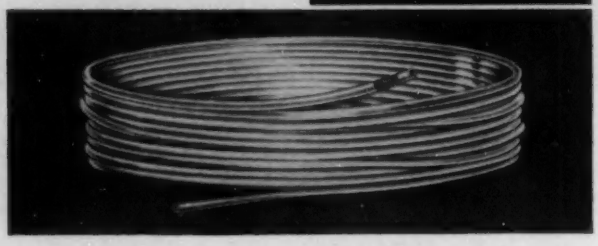
Manufacturer of Standard and Special 12 Point and Hexagon Nuts . . . "Huglock" and "Marsden" locknuts.

44251 Utica Rd., UTICA, Michigan





Design with economy in mind



Specify strong, economical, easy working ALCOA UTILITUBE for fuel gas lines

ALCOA® Utilitube, lightweight coiled aluminum tube made of a special ALCOA alloy, can cut costs, assure top performance in fuel gas line applications . . . in gas engines, cooking stoves, water heaters, unit heaters and other gas-fired appliances.

ALCOA Utilitube is strong. It has high fatigue strength, stands up well under vibration. In addition, ALCOA Utilitube is corrosion resistant, clean in appearance.

ALCOA Utilitube is economical. It costs up to 40% less than copper, and if desired, it may be had in long lengths of up to 1,000 feet or more.

ALCOA Utilitube is easy-working. It work hardens less than other metal tube, bends more easily than annealed copper, has good flaring and forming characteristics.

ALCOA Utilitube has advantages you can't overlook when designing any type of gas-fired appliance, stove or heater. In addition to fuel gas lines, you can use ALCOA Utilitube for refrigerants, air, oil and other fuel lines, and for hydraulic fluids. When the design calls for coiled tube, specify ALCOA Utilitube.

Write today for ALCOA's FREE booklet, *Alcoa Utilitube*. It has all the information on this versatile ALCOA product.

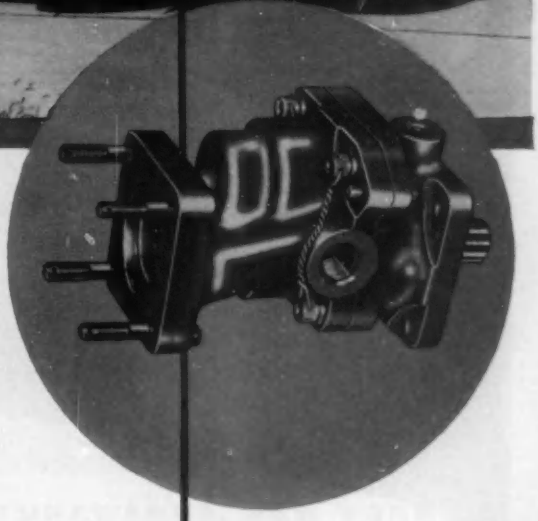
ALUMINUM COMPANY OF AMERICA
909-E Alcoa Building, Mellon Square
Pittsburgh 19, Pennsylvania

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Why the first gas turbine bus uses a Pesco fuel pump

Gas turbine transit bus, first of its kind, uses a 325-horsepower single burner turbine instead of the conventional diesel engine. Power plant engineers solved problem of fuel pump performance and service life with Pesco unit.



Are you developing or producing gas turbine engines for automotive, marine, aircraft or industrial applications? Then it will be of essential interest to know why the world's first gas turbine bus uses a Pesco High Pressure Fuel Pump.

On this radical new bus, the Pesco pump provides a continuous and dependable flow of fuel over an extended service life. It operates at sustained high volumetric efficiencies in spite of (1) the relatively high fuel system pressures encountered with gas turbine engines and (2) the inherent lack of lubricating value of the fuel.

The reason for such superior performance is the exclusive Pesco principle of pump design—"Pressure Loaded" bearings. This feature maintains continued new pump performance by automatically compensating for wear. It also assures constant pumping characteristics regardless of changes in temperature, viscosity or load.

Pesco, foremost producer of fuel pumps for aircraft jet engines, can supply fuel pumps for any type or size of gas turbine equipment. We will be pleased to work with you in developing a fuel pump to meet your specific requirements. Why not call in a Pesco sales engineer today. Contact: PESCO, 24700 North Miles Road, Bedford, Ohio.

Model 022816 High Pressure Fuel Pump, being used experimentally on gas turbine bus, is an engine-driven, gear-type unit. Compact in design and weighing only 3½ pounds, it is rated at 2.3 gpm at 3000 RPM at 650 psi.

engineering Pesco production

PRODUCTS DIVISION

BORG-WARNER CORPORATION

24700 NORTH MILES ROAD • BEDFORD, OHIO

FOR THE TOUGHEST JOBS IN FLUID CONTROL..

HOKE

270 series bar stock needle valves

- high pressure air or hydraulic service (pressures to 4,000 psi)
- for instrument panels and test stands
- non-critical high vacuum applications

Hoke's 270 Series offers a choice of O-ring seal or a variety of packing materials (including Teflon) to meet specific requirements . . . The stem is self-aligning for tight closure . . . and Hoke's back-seating feature makes it possible to replace O-ring or packing under pressure.

In brass or stainless, to fit ⅛", ¼", ⅜" and ½" pipe sizes. Available with panel mounting for instrument panel and test stand service.

We'll be glad to send you complete technical information.

HOKE

HOKE INCORPORATED

Fluid Control Specialists

197 S. DEAN STREET, ENGLEWOOD, N. J.

Mayline

5-DRAWER UNIT

MAYLINE Metal Plan Files Intermember

Mayline plan files intermember into firm, solid, safe filing units. They have hinged dust covers, and a very fair price. See your local dealer, or write for folder S-20.

5 DRAWER UNITS STACKED

PLAN FILE WITH HINGED DUST COVER

MAYLINE

MAYLINE CO.

605 No. Commerce St.

Sheboygan, Wisconsin

Mayline

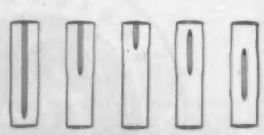
FASTEN, HINGE or PIN *with* DRIV-LOK PINS

FASTER ASSEMBLY... LOWER COSTS

POSITIVE ANCHORING ...won't come loose

DRIV-LOK Pins are responsible for great economies and product improvement in thousands of applications. For machinery, finished products, components and sub-assemblies, DRIV-LOK Pins offer definite advantages in time, labor and cost savings. We can help you better if you will write, giving us the nature of your problem. Catalog and Samples sent without obligation.

STANDARD TYPES a type for every need.



Type A Type B Type C Type D Type E
Also Types F and G

WRITE FOR CATALOG

DRIV-LOK PIN COMPANY

723 Chauncy Street Sycamore, Illinois

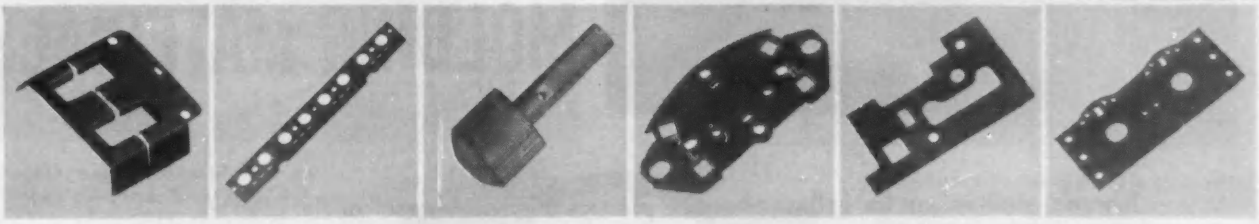
Spaulding

PRODUCTS FOR INDUSTRY

TAKE ADVANTAGE OF SPAULDING'S "START TO FINISH" SERVICE ON PARTS PRODUCTION

Spaulding basic materials offer a wide variety of electrical, chemical and physical property combinations which make them ideal for solving parts design problems throughout all industry. To utilize these materials to best advantage, call on Spaulding's "start to finish" service. This includes consultation at the design stage, manufacture of the basic materials and fabrication of the finished parts.

We can often suggest practical modifications of design or grade of material that will reduce your costs. By having us fabricate your parts, you eliminate the need to carry stocks of basic materials or to invest in the special equipment often required for maximum efficiency. Since all operations are carried on in our own plant, you can be sure your order will be handled expertly, expeditiously and without shift of supervision or responsibility.



SPAULDING FIBRE COMPANY, INC., TONAWANDA, NEW YORK

WE MAKE AND FABRICATE

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

SPAULDITE: (Laminated Phenolic Plastic) in sheets, rods, tubes and fabricated parts.

SPAULDO: Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board, in sheets and fabricated parts.

MATERIALS HANDLING EQUIPMENT: Factory trucks, Boxes, Barrels, Trays, etc.

SPAULDING FABRICATING FACILITIES
Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation.

SPAULDING BRANCH SALES OFFICES

BALTIMORE 18, MD.
BOSTON 16, MASS.
BRIDGEPORT 5, CONN.
CHICAGO 25, ILL.
CHICAGO 38, ILL.
CLEVELAND 14, OHIO
CLEVELAND 16, OHIO (Rocky River)
DAYTON 2, OHIO
DETROIT 1, MICH.
FORT WAYNE 6, IND.
LANSING 10, MICH.
LONG ISLAND, N. Y. (Woodhaven 21)
MILWAUKEE 8, WIS.
NEW YORK 55, N. Y.
NEWARK, N. J. (Union, N. J.)
PHILADELPHIA, PA. (Camden 3, N. J.)
ST. LOUIS 5, MO.
TONAWANDA, N. Y.
WESTFIELD, N. J.
LOS ANGELES 15, CAL. C. D. LaMoree
BERKELEY 10, CAL. C. D. LaMoree
TORONTO 18, ONT., CANADA A. A. Andersen & Co.

FORMULATED TO FIT DESIGNERS' NEEDS...

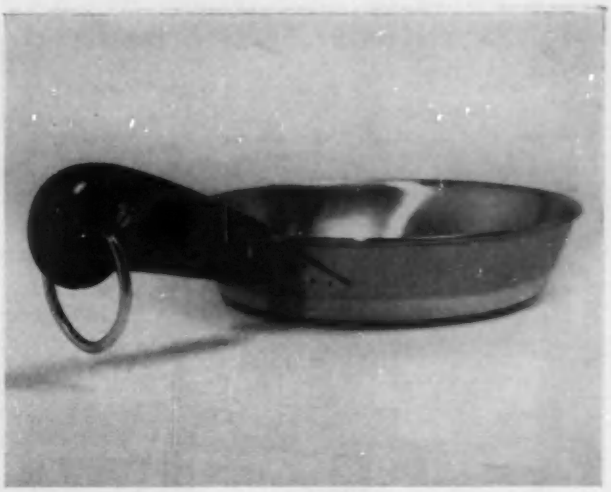
4 GROUPS OF "BAKELITE" TRADE-MARK PHENOLIC MOLDING MATERIALS

There's good reason for calling phenolic plastics the "workhorse" of the plastics industry. They do so many jobs so well. Beyond that, some types emphasize special properties for special kinds of work. To take advantage of their range of possibilities, Bakelite Company produces four types—general-purpose, "low loss" insulation, heat-resistant, and improved impact phenolic molding materials.

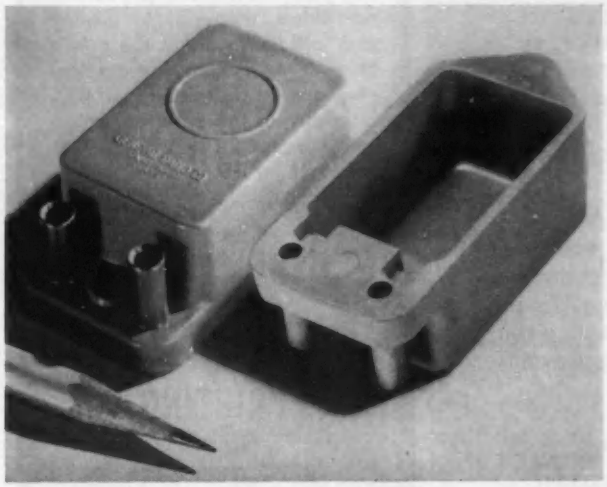
This means that you can select a BAKELITE Brand Phenolic molding material closely fitted to your job requirements. You can be sure that it has been produced under rigid quality control standards, backed by Bakelite Company's 45 years of experience in plastics. And in selecting and applying the right material to your product, you can call on the help of qualified Bakelite Company technical representatives. Write Dept. HL-145

GENERAL-PURPOSE PHENOLICS • IMPROVED IMPACT PHENOLICS
HEAT-RESISTANT PHENOLICS • "LOW LOSS" INSULATION PHENOLICS

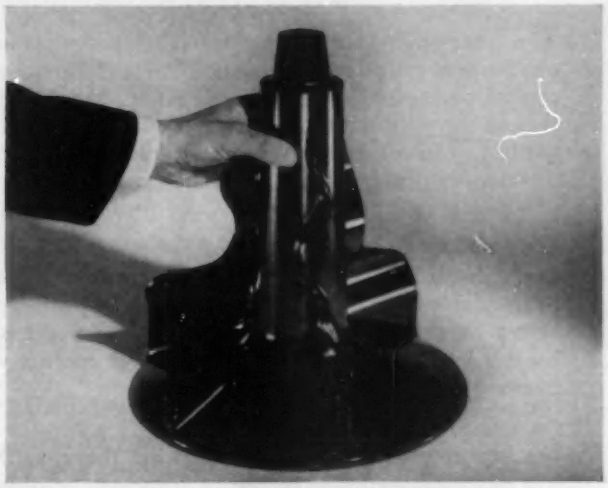
All-round serviceability is important in a telephone handset. So is good appearance. This one has both because it's molded of BAKELITE General-Purpose Phenolic BMG-5000 Black 25. Molding details are excellent, for example, in the case of the precisely formed inner sections that hold sensitive electrical components in place. The rich black color and smooth, glossy surface add strong eye-appeal. (Molded by Northern Industrial Chemical Co., Boston, Mass., for Stromberg-Carlson Co., Rochester, N. Y.)



Heat resistance is on a par with handsome design when it comes to handles for cooking utensils such as those molded from BAKELITE Heat-Resistant Phenolic BM-13335. This one is styled for good appearance. It gives a comfortable, safe, sure grip, won't get too hot to hold. The handle will withstand intermittent exposure to temperatures up to 500 deg. F. (Handle for Revere Ware molded by Diemolding Corp., Canastota, N. Y. and Norton Laboratories, Lockport, N. Y.)



Superior electrical insulation is provided by BAKELITE "Low Loss" Insulation Phenolic BM-17748. This material is more resistant to moisture and is more dimensionally stable than most phenolic molding materials. Used for this capacitor housing, it reduces dissipation factor and leakage conductance. Other applications for this material include coil forms, vacuum tube bases, and resistors. (Molded by Bay State Molding Co., Dorchester, Mass., for General Radio Co., Cambridge, Mass.)

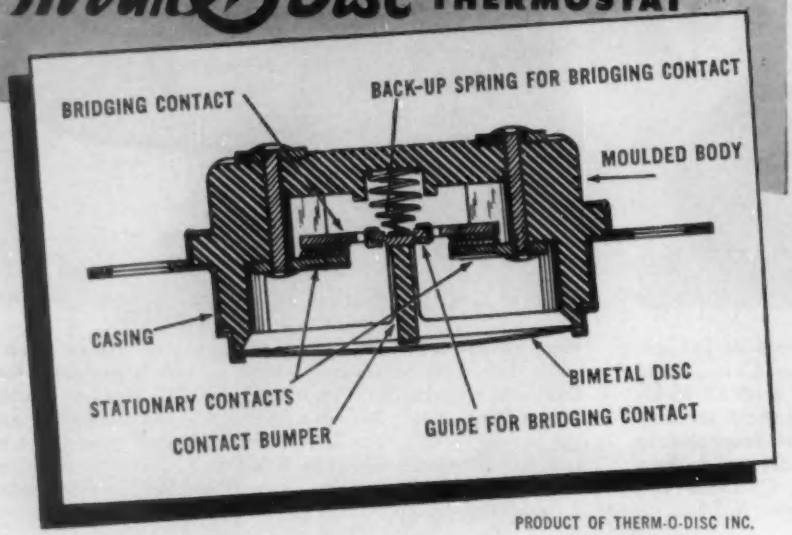


Resistance to both impact and hot soapy water is the governing factor in choice of a material for washing machine agitators. This one is molded in one piece from BAKELITE Water-Resistant Improved-Impact Phenolic BM-12315 Black. It withstands soaps, detergents, bleaches, and scalding water. The serpentine vanes are an unusual molding feature, but BM-12315 reproduced them with a glossy surface free of haze or flow marks. (Molded for the Whirlpool Corporation by Modern Plastics Corp., Benton Harbor, Mich.)

BAKELITE
BRAND
Phenolic Plastics

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE Therm-O-Disc THERMOSTAT



PRODUCT OF THERM-O-DISC INC.
MANSFIELD, OHIO

The Thermo-O-Disc Thermostat is a preset, snap-action, non-adjustable type control device which provides temperature control of unusually heavy loads up to 350°F. It is widely used in such familiar applications as clothes dryers, room and unit heaters, central heating furnaces and in many miscellaneous devices for positive control and limit protection.

Outstanding features of this thermostat include an accurate, dependable Chace Thermostatic Bimetal disc element, a double break contact feature with large contacts to insure long life on heavy electrical overloads and the high contact pressures given by the back-up spring for the bridging contact which prevents overheating.

The important actuating element of the Therm-O-Disc Thermostat is a precalibrated disc of Chace Thermostatic Bimental which, at the critical, preset point of temperature rise, snaps from a normally concave to a convex position. The impact of this positive snap-action of the bimetal disc against the contact bumper causes an immediate make or break of the circuit. The free bimetal disc principle eliminates the possibility of variation in calibration by permitting the disc to operate unstressed. Its positive snap-action does not allow radio or TV interference.

Chace Thermostatic Bimetal is available in 29 different types, in strip, coils or in complete elements fabricated to customer specifications. Send for our new, free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing valuable engineering information for designers of thermally responsive devices.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1607 BEARD AVE., DETROIT 9, MICH.

ON OUR STAFF

If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, and perform any of the other communicative functions vital to your business, let TECHNICAL WRITING SERVICE do the job for you.

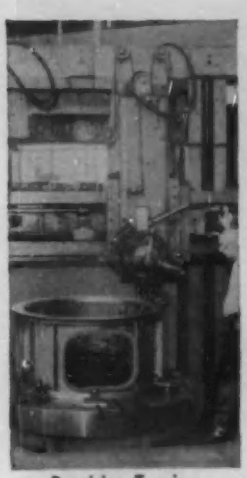
WRITING • EDITING
ILLUSTRATING
PRINTING

We produce your publications, to your specifications. We give complete service—from research and planning through writing, design, and printing. Let our staff be your staff. It will save you time and money.

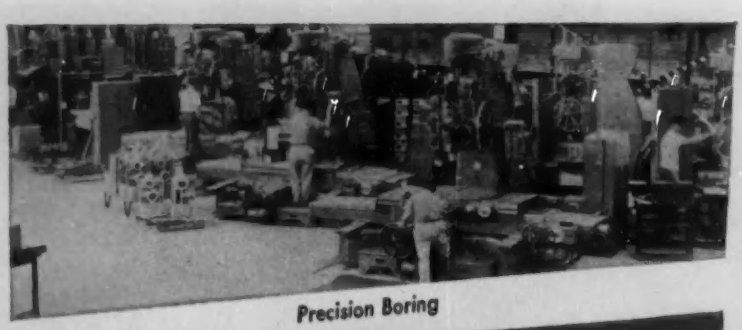
— We Prepare —
EQUIPMENT MANUALS
HANDBOOKS • PRODUCT
BULLETINS • TRAINING AIDS
PAMPHLETS • REPORTS
BROCHURES • COMPANY
HISTORIES • PARTS LISTS
and other such special material.

Write • Phone
TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.
LOngacre 4-3000

Special
ROLL
FORMED
SHAPES
. . . in RINGS
or STRAIGHT LENGTHS
ROLL FORMED shapes and bends rings continuously. Notching and piercing may be accomplished in the same operation. Accurate ROLL FORMED rings reduce scrap unavoidable in other manufacturing methods. Your rejects are eliminated. Let us show you how to reduce assembly costs on carbon, galvanized and stainless steel, aluminum, copper, zinc and clad metal shapes of all types.
MAIN OFFICE AND PLANT
3756 OAKWOOD AVE. • YOUNGSTOWN, OHIO
ROLL FORMED PRODUCTS
COMPANY
Write for
ROLL FORMED
Catalog 1053



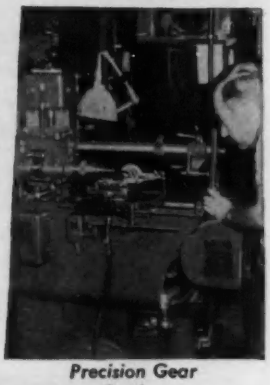
Precision Turning and Boring



Precision Boring

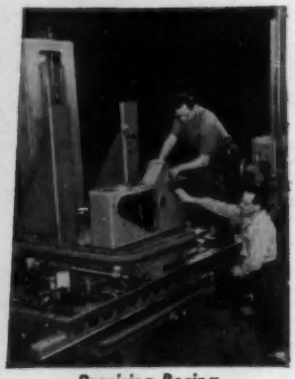
Precision Welding

Instrument Plating



Precision Gear Cutting

Hobbing 56" Ring Gear

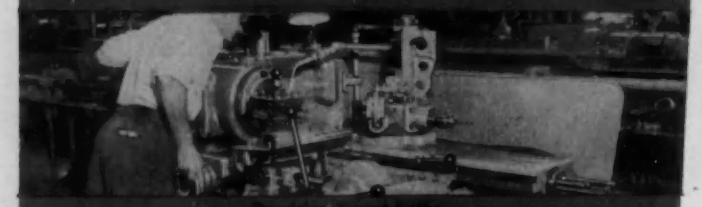


Precision Boring, Turning and Threading

...from drawing board

—TO FINISHED PRODUCT, DAYSTROM DOES THE COMPLETE JOB

A modern plant of 350,000 square feet ... the finest machinery and equipment for the manufacture, assembly and test of precision electronic, electro-mechanical, mechanical and nuclear instruments ... add to these a highly skilled staff of research, development, engineering and manufacturing specialists and an experienced management ... means Daystrom can do the complete job, from drawing board to finished product ... ALL UNDER ONE ROOF!



Precision Turret Lathe

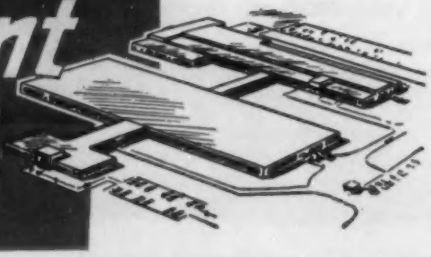
Daystrom Instrument

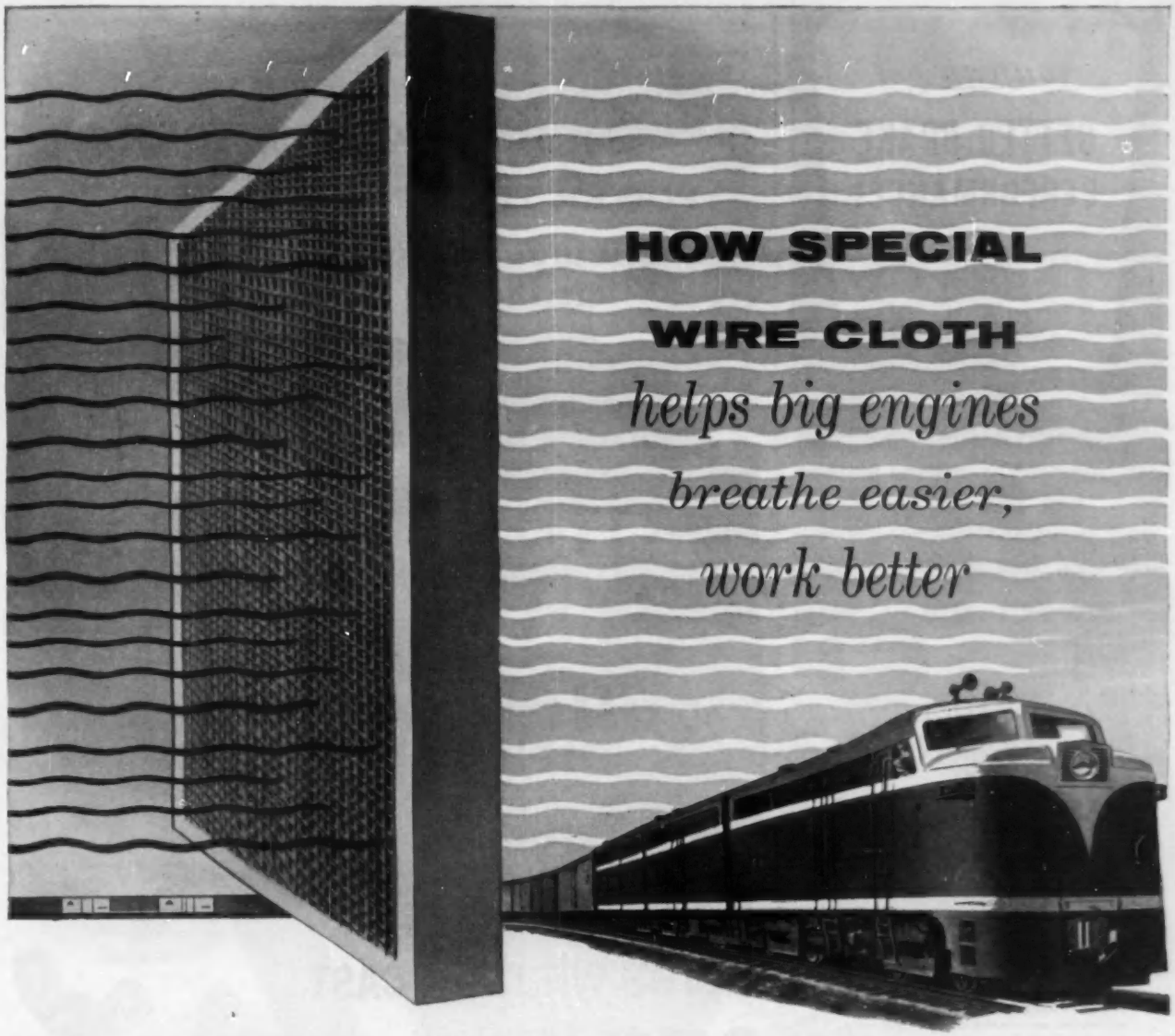
Division of Daystrom, Inc.

Archbald, Penna.

Daystrom Affiliates:
American Gyro; Heath Company;
Daystrom Electric Corp.;
American Type Founders, Inc.;
Daystrom Furniture Div.

Write For Our Brochure





● Keeping harmful grit and dirt out of the lungs of big engines, like locomotive diesels, is no small problem. Determined to do the job better than ever before, a leading filter manufacturer turned to the *Reynolds Wire Division* of National-Standard for a special wire cloth that would trap all the dirt and still let such engines breathe the terrific volume of air they need.

No simple assignment this, for it took months of concentrated development work—not only to develop the *kind* of wire cloth that would do the job, but also to find out *how best* to produce it. It had to be slit into narrow widths, with special lock wires to prevent raveling. It had to withstand a patented method of severe forming and crimping without compacting. And despite the special construction and narrow slitting, it had to be furnished in extra large continuous rolls. All were tough problems to lick!

The *ability* to lick a tough problem in wire cloth is one thing. The *willingness* to do it is quite another. You get *both* at Reynolds Wire. But, problem or no problem, short orders or large volume production, you too will find it pays to turn to Reynolds. Try us and see.

NS
NATIONAL-STANDARD Company
NILES, MICHIGAN

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape
ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel
REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth
WAGNER LITHO MACHINERY DIVISION • JERSEY CITY, N. J.
Special Machinery for Metal Decorating
WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

you can get

BETTER BRAKE PERFORMANCE!

amazing NEW

WORLD BESTOS

FRICTION MATERIALS

stop brake fade and glaze . . . assure constant friction and longer life of trouble-free service.

Brake fade, glaze, short lining life and excessive wear mean costly brake maintenance and production losses that affect the service record of your product.

World Bestos, specializing for more than 30 years in the manufacture of friction materials, supplies blocks, linings and segments engineered to solve your brake problems . . . to give your brakes a longer life of dependable, trouble-free service.

Proven friction materials for brakes on cranes, drilling rigs, hoists, drag lines, large forming presses, elevators or any type of industrial application. Also linings for automatic transmissions, torque converters and automatic clutches.

For prices and delivery information send prints or specifications to WORLD BESTOS, Industrial Products Section, New Castle, Ind. Engineering and development service is available. Write for free folder.

WORLD BESTOS

NEW CASTLE INDIANA

DIVISION OF THE

Firestone

TIRE & RUBBER CO.

for *Chain Drive* users

WHAT'S YOUR POWER TRANSMISSION NEED?

driving . . . conveying . . . timing . . .

There's a cullman chain drive for every purpose

Keep installation and operating costs down with efficient, economical Cullman roller chain drives. They deliver more for less . . . save space, increase your equipment capacity, absorb shock loads.

For more machinery production and guaranteed, long trouble-free service specify Cullman on your next chain drive installation. Why not take advantage of 60 years of experience in engineering and producing the right chain drive?

33853

cullman

POWER TRANSMISSION ROLLER CHAINS AND SPROCKETS

Write today for Catalog 51, or see your local Cullman distributor.

REPRESENTATIVES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

CULLMAN WHEEL COMPANY, 1134 ALTGELD STREET, CHICAGO 14, ILLINOIS

here's what **DIE CAST**

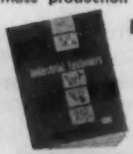
GRC ZINC ALLOY THREADED

FASTENINGS

mean to you...

in terms of a better product, in terms of a more economical product!

Gries' unique techniques make possible closer tolerances, cleaner threads, greater dependability, durability, die-cast uniformity. Mass production means lower costs!



NEW BULLETIN AVAILABLE

Fact-packed—shows how Gries ingenuity and money-saving methods can solve your fastenings problems.

Send today for your copy, prices and samples.

GRIES REPRODUCER CORP.

159 Beechwood Ave., New Rochelle, N. Y.
Phone: NEw Rochelle 3-8600

GRC

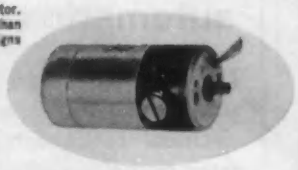
World's Foremost Producer of Small Die Castings

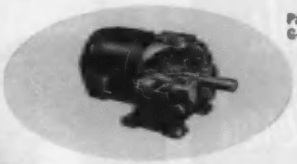
Torq-Master, used with torque converters and fluid couplings in the lumber industry

Giant gear and rack

Right angle vertical pump drive

Miniature motor. One of more than 50 basic designs





Pacific, G-E gearmotor

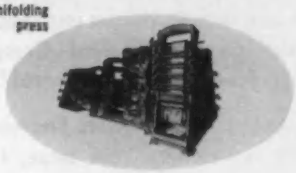
look to

WESTERN GEAR for

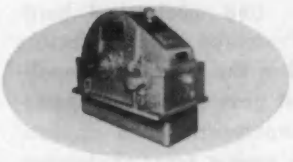
- custom engineering
- specialized machinery for every purpose
- complete line of electro-mechanical catalog products
- gears of all types and sizes

Illustrated are only a few of the wide variety of both custom and standard products designed and manufactured by Western Gear.

Manifolding press



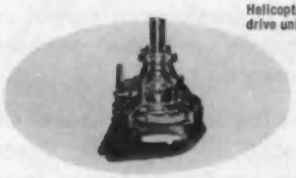
Right angle speed reducer



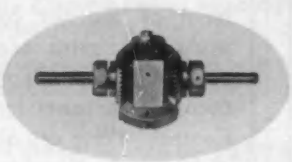
High speed unit

Centrifugal blower, one of many design sizes

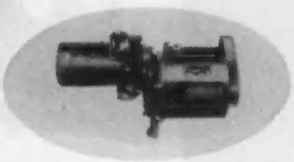
Helicopter rotor drive unit



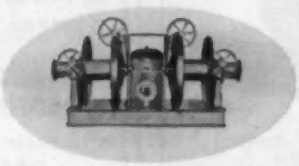
Sea-Master marine gear



Miniature precision differential unit

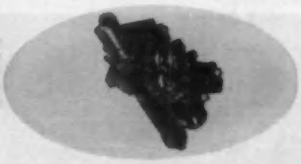


Aircraft cable drum type hoist, hydraulic, pneumatic or electric drive



Trawl winch

Rotary actuator powered by both hydraulic and electric motors. One of hundreds of basic designs



Horizontal stabilizer actuator unit. AC and DC power providing three speeds for manual, auto pilot and coarse control

"The difference is reliability" • *Since 1888*

Engineering service available without obligation. Let us quote you on your needs.

WESTERN GEAR

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

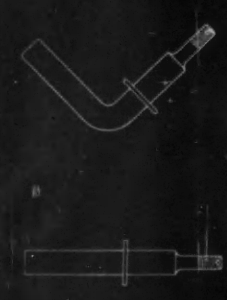
Address Executive Offices, Western Gear, P.O. Box 182, Lynwood, California

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON... REPRESENTATIVES IN PRINCIPAL CITIES

"ELECTRIC"

Wheels Engineered for the Job

WRITE US FOR RECOMMEN-DATIONS



Rear Tractor Wheel for Demountable Rim
Planter Press Wheel—one piece rim with or without rubber tire
Rear Tractor Wheel Reversible
Pick-up Wheel Crown-face Steel Rim
Garden Tractor Wheel Reversible
Combine Wheel Reversible
Press and Gage Wheel Rubber Tire
Spreader Wheel
SAE Implement Wheel Reversible

ELECTRIC WHEEL COMPANY

2805 SPRUCE · QUINCY, ILLINOIS

Latest Data on MECHANICAL COMPONENTS for automatic control

The great demand for reprints of our special report on rotating *electrical* components for automatic control prompted us to publish also in reprint form our special report on "*Mechanical* Components for Automatic Control."

Reprinted from *Product Engineering's* September, 1954 issue, this 32-page report covers gearing, clutches, and mechanical hardware. Presented are the factors involved in the design and application of gear trains, the operating characteristics and applications for various types of clutches, and a discussion of typical commercially available mechanical elements.

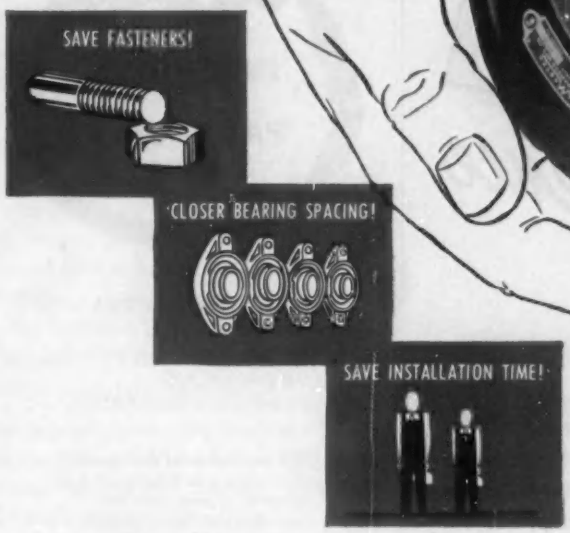
You can order "*Mechanical* Components for Automatic Control" from our Reader Service Department at 50¢ per copy. And if you'd like extra copies of the previous report, "Rotating *Electrical* Components for Automatic Control," these are also available at 50¢ each. However, the supply is limited, so order your copies now.

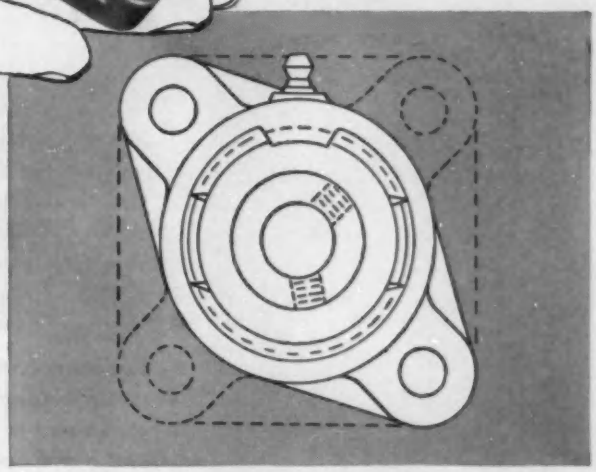
BOTH REPORTS ARE PROFUSELY ILLUSTRATED WITH GRAPHS, DIAGRAMS, CUTAWAY DRAWINGS, TABLES, AND PHOTOGRAPHS.

32 PAGES **50¢ EACH**

Product Engineering
McGraw-Hill Building,
New York 36, N. Y.

NOW! SEALMASTER cuts corners to save DOLLARS for you!





Check these facts!

- Cuts installation costs by eliminating two fasteners and punching or drilling operation required for two mounting holes.
- Permits closer bearing spacing on multiple shaft installations.
- As a replacement bearing unit fits the diagonal bolt centers on present four-bolt flange units.
- Carries the same load rating for a given shaft size as four bolt units.
- Retains all patented design features of SEALMASTER Bearing Units—Zone Hardening, Self-Alignment, Locking Pin & Perimeter Dimple and Labyrinth Seal.
- Available in shaft sizes from ½ to 2 15/16 inches.

New SEALMASTER 2-BOLT FLANGE UNIT

Call your SEALMASTER Distributor or mail this coupon today!

Please send Bulletin SS-125 containing full information on the new SEALMASTER 2-Bolt Flange Ball Bearing Unit.

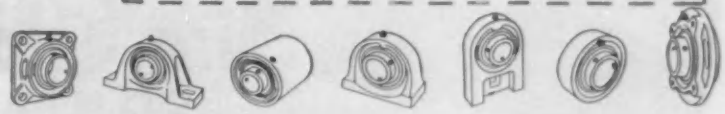
NAME_____

FIRM_____

ADDRESS_____

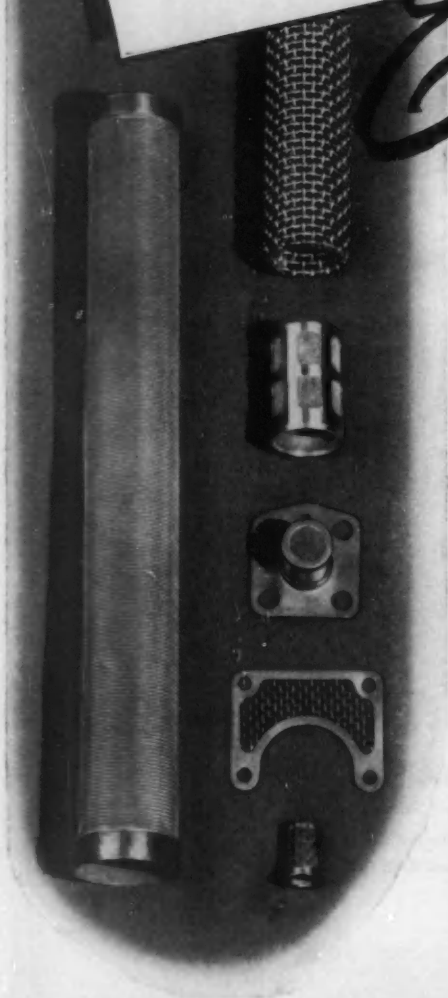
CITY_____ STATE_____

SEALMASTER BALL BEARING UNITS



SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. • 9 RIDGEWAY AVE., AURORA, ILLINOIS

NEWARK offers Superior "Fabricating and Assembling" Experience



We at Newark have many years' experience in the production of quality wire cloth. But we haven't stopped there. One division of our company is fully equipped and staffed to fabricate *any* part you need with a wire cloth insert.

We have experienced engineers ready to assist yours in the design of the part to assure making the best and most economical use of the mesh insert. And, we have the facilities and skilled personnel to fabricate the parts to your strict specifications in small lots or in production quantities to meet your production schedules.

It will pay you to investigate how you can take advantage of our experience in wire cloth manufacture and parts assembly. We shall be glad to quote on your requirements. Let us have complete details on specifications.

NEWARK for ACCURACY

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Send for Catalog E.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

FOR ELECTROMECHANICAL DESIGNERS... IN THE DEVELOPMENT OF RADAR AND COMPUTING EQUIPMENT.

The most advanced developments in electronics are being made in the sphere of airborne radar and related ground control systems because of military emphasis. Further applications of electromechanical techniques in these fields are creating new openings in the Systems Division of Hughes Research and Development Laboratories.

Engineers who have demonstrated ingenuity and inventive ability will find interest in areas of work that call for devising reliable, maintainable, manufacturable designs for precision equipment developed at Hughes Research and Development Laboratories.

The design of this equipment, manufactured at Hughes, involves mechanical, electromechanical, electronic, microwave and computing problems. Design also requires the use of such advanced techniques as subminiaturization, unitized "plug-in" construction, with emphasis on design for volume production. Knowledge of electronic components, materials, finishes and military specifications is useful.

ENGINEERS

experienced in the field of electromechanical design at the research and development level, or those interested in entering this area, will find outlets for their abilities and imagination.

SCIENTIFIC AND ENGINEERING STAFF

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County California

(*Advertisement*)

"O" Rings *by Automation*

Automation, the "push-button" by-word of modern manufacturing, has come to the "O" Ring industry!

A new, fully automatic process, known as *Roto-Molding* is producing true compression molded "O" Rings of the highest quality, at production rates never before attained.

The Industry's Newest Development

Roto-Molding is entirely revolutionary in its approach to "O" Ring manufacture. It has been called the greatest advance made in this field in years. A completely automatic machine, working under precise, fully-instrumented control, is now turning out Roto-Molded "O" Rings at mass production rates and costs. But that is not the entire story. The quality of these rings is superior in several important respects:

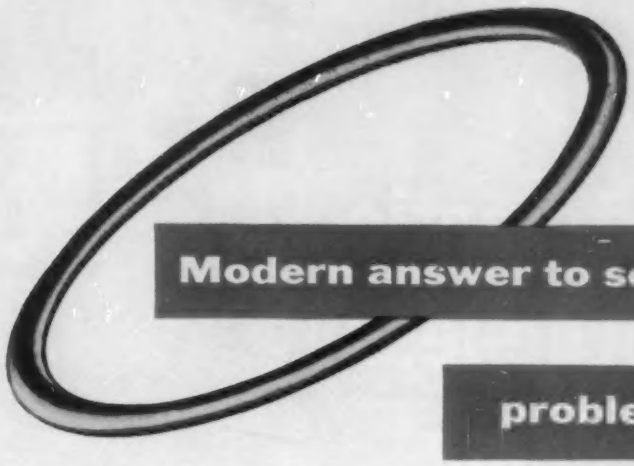
For example, every ring receives exactly the same time, temperature and pressure during the cycle, insuring improved physicals and a uniform ring.

Pre-stretched grain structure—a highly desirable quality that is impossible to achieve with injection or transfer molded rings, is an assured result with the new automatic process. The process minimizes compression set . . . and dimensional stability is achieved.

Uniform Quality Maintained

The *Roto-Molding* process also produces "O" Rings with flash-free finish and the precise, uniform tolerances needed for modern sealing applications. Handling of the rings is completely automatic, so they are free from contamination through foreign inclusions, and other minute imperfections which may be cause for rejection in non-automatic molding processes. With the *Roto-Molding* process, uniformity in quality is possible and the A.Q.L. (acceptable quality level) is maintained for all applications.

Because they are automatically mass produced, *Roto-Molded* "O" Rings are now delivered in large quantities in a fraction of the time previously required for emergency commitments. They are available in a wide variety of sizes and materials, including the newest silicone compounds. Complete information on standard or special applications may be obtained by writing LINEAR, Inc., State Road and Levick Street, Phila. 35, Pa.



Modern answer to sealing problems

Linear roto-molded "O" rings

Now LINEAR offers premium quality "O" Rings at mass production prices!

ROTO-MOLDING, LINEAR's new, exclusive, entirely automatic method, eliminates human error—assures precise uniformity in every ring. The maintenance of the A.Q.L. (acceptable quality level) in LINEAR ROTO-MOLDED "O" Rings assures the maximum number of acceptable units at the test stand. Time wasted in disassembly and reassembly due to faulty "O" Rings is reduced to a minimum.

ROTO-MOLDING produces "O" Rings with tough, homogeneous structure, flash-free surface and dimensional stability with improved physicals. They withstand the brutal surge and back pressure of hydraulic systems . . . resist extremes of heat and cold, and take mechanical abuse never before thought possible.

You can get LINEAR ROTO-MOLDED "O" Rings in a variety of standard and special materials to meet the requirements of use with destructive synthetic fluids, or in the latest silicones with exceptional thermal characteristics.

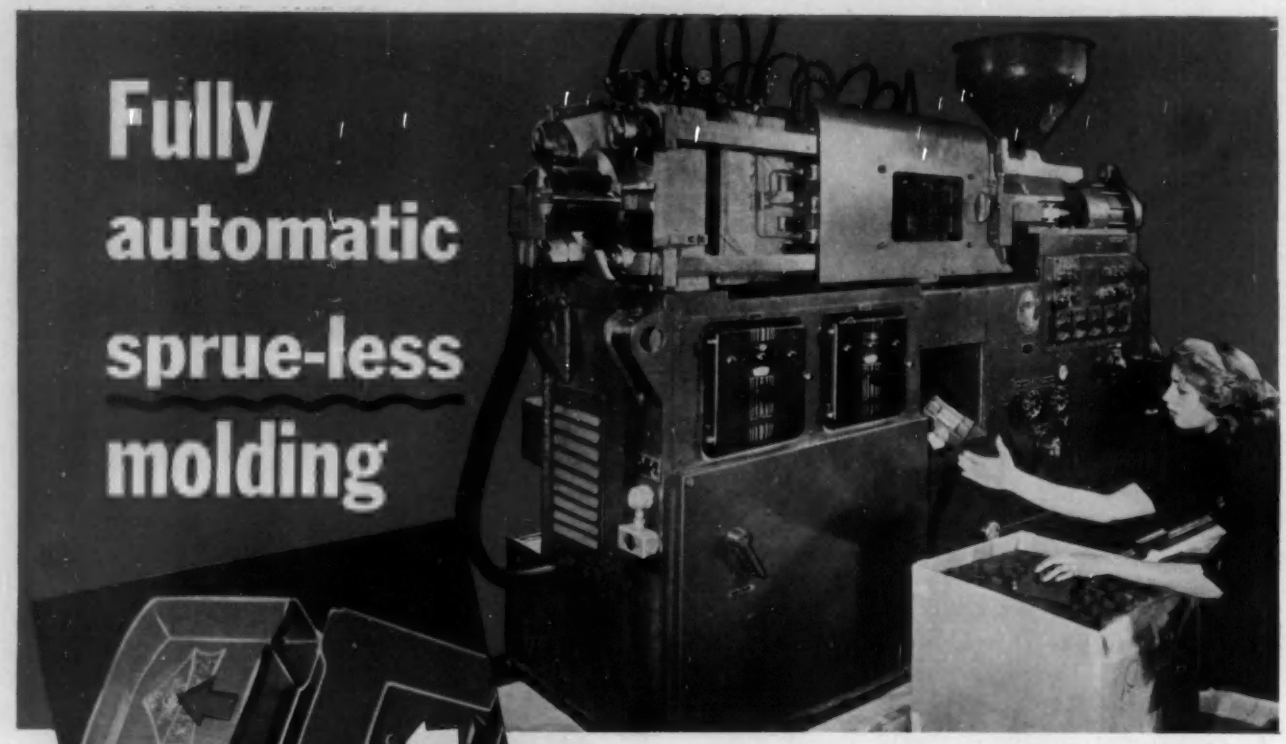
Write or call for the facts now!

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Fully automatic sprue-less molding



Arrows indicate injection point of material. Base of this Styrene case measures 5⅛"x4⅜"x1½"; the cover, 5⅛"x4⅜"x1¾".

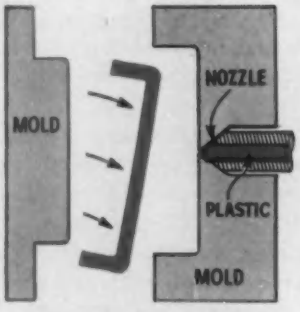
with Fellows Model 1B-3-15 keeps costs down for J. & M. Zadiix Products Co.

Here's how J. & M. "Zadiix" Products Company, Brooklyn, New York licked the problem of economically producing a combination Styrene case for 35mm. color viewer and slides.

They decided upon the sprue-less molding technique because it eliminates cutting off the sprue and finishing...eliminates grinding of waste material...speeds the cycle.

They selected the Fellows 1B-3-15 Injection Molding Machine because it provides completely automatic, high-speed production...5 covers per minute...2½ bases. Also, the complete dependability and consistent molding performance of Fellows machines assures them uniformity of product.

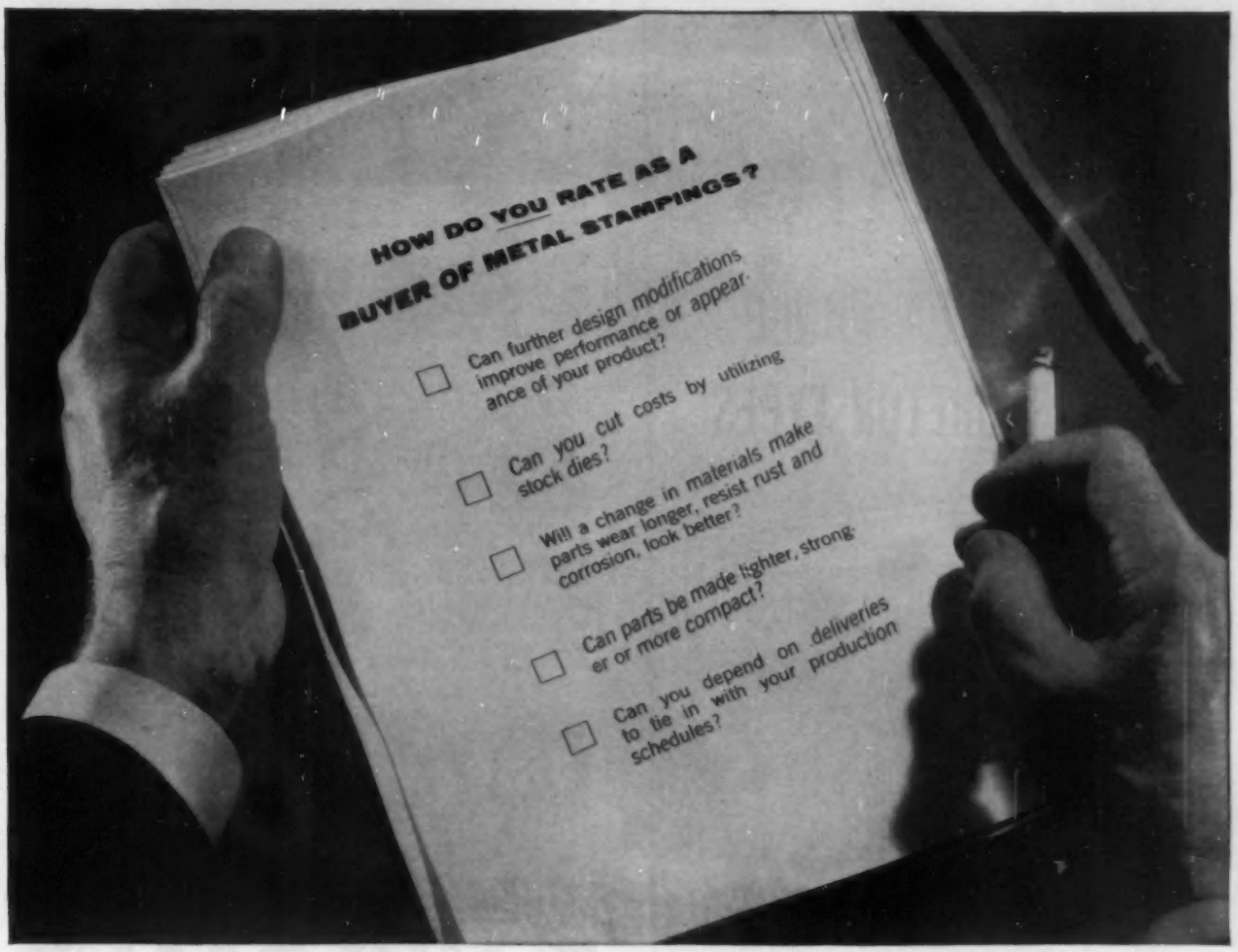
Get the full story of "automation" from a Plastics Machine Specialist at any Fellows Office. Write, wire or phone today!



The extended nozzle technique, as shown, is the basis of molding sprue-less, ready-to-assemble products.

Fellows injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY, Plastics Machine Division, Head Office and Export Department, Springfield, Vermont
Branch Offices: 319 Fisher Bldg., Detroit 2 • 5835 West North Ave., Chicago 39 • 2206 Empire State Bldg., New York 1
5 Martel Bldg., 6214 West Manchester Ave., Los Angeles 45.


HOW DO YOU RATE AS A
BUYER OF METAL STAMPINGS?
Can further design modifications improve performance or appearance of your product?
Can you cut costs by utilizing stock dies?
Will a change in materials make parts wear longer, resist rust and corrosion, look better?
Can parts be made lighter, stronger or more compact?
Can you depend on deliveries to tie in with your production schedules?

can your metal stamped parts be improved or produced at greater profit* to you?

To tell you "how" and "why" it may be possible, The Crosby Company has just published an informative report: "Removing the Questionmarks from Metal Parts Procurement". In it, you will find specific ways in which Crosby can assist you in checking every major design and cost factor relating to metal stamped parts.

Much more than a production stamping plant that merely "bids" on jobs, The Crosby Company makes a thorough study of every metal stamping inquiry. You receive an *Engineered Quote*. Often products are improved, money saved and profits increased as a direct result.

You can obtain the complete story without cost or obligation. Simply fill in and mail the coupon below.

METAL STAMPINGS SINCE 1896 · THE CROSBY COMPANY · BUFFALO, N.Y.

***REMOVE ALL DOUBT—**
GET A CROSBY ENGINEERED QUOTE

THE CROSBY CO. 215 Pratt Street, Buffalo 4, N. Y.

Mail a copy of your report, "Removing the Questionmarks from Metal Parts Procurement" without cost or obligation.

Name ..... Title .....

Company .....

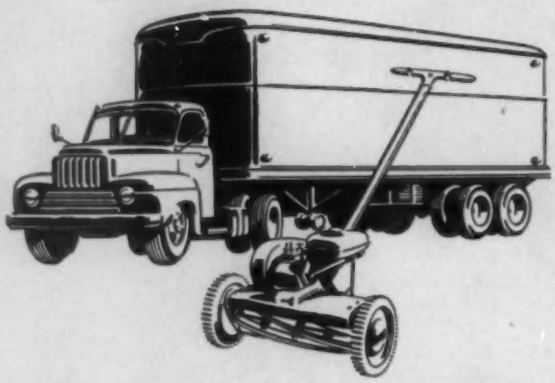
Address .....

City ..... Zone ..... State .....

SALES OFFICES: Buffalo • Cleveland • Detroit • Chicago • New York • Philadelphia

Zenith

HAS A WIDE RANGE OF CARBURETOR TYPES



TO FIT A WIDE RANGE OF APPLICATIONS!

Are you looking for an unusual size or type of carburetor? Perhaps Zenith* has the answer to your problem. For more than 35 years Zenith has been designing and building carburetors for every type of engine—ranging from single cylinder lightweights to the most rugged and powerful of gasoline engines. The chances are you can use a unit Zenith is now making and avoid the cost of a specially designed carburetor.

On the other hand, if your carburetor requirements are highly specialized, Zenith's engineering experience will prove invaluable in solving questions of placement, efficiency and economy of operation. Just remember, whatever your carburetor problem, it will pay you to look to Zenith for the answer.

*REG. U. S. PAT. OFF.

ZENITH CARBURETOR

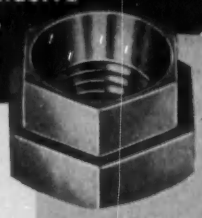
DIVISION OF **Bendix**
AVIATION CORPORATION

696 Hart Avenue, Detroit 14, Michigan

MANUFACTURERS OF FINE CARBURETORS AND FUEL FILTERS

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

use these
GRIPCO CLINCH NUTS
with the exclusive
hex on hex
feature

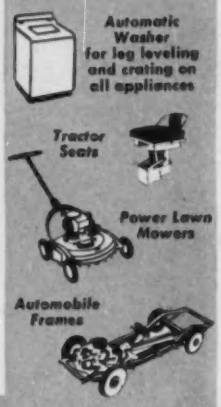


for "fixed" fastenings for "hard-to-reach" or blind assemblies. They wear longer, hold tighter, give greater customer satisfaction.

See how leading appliance manufacturers get lower cost fasteners into inaccessible places.

Gripco Clinch Nuts can be either clinched solid for a rigid application or staked in with a six point staking punch to give a floating effect. This floating effect takes care of misalignment and makes the application of the bolt easier. Gripco clinch nuts can be clinched or staked with stationary or portable hydraulic or air equipment. Details on request. Write for samples and data sheet.

Typical Applications



GRIP NUT COMPANY 113

308-J S. Michigan Avenue, Chicago 4, Illinois

VULCAN
ELECTRIC HEATING UNITS

On Airplanes

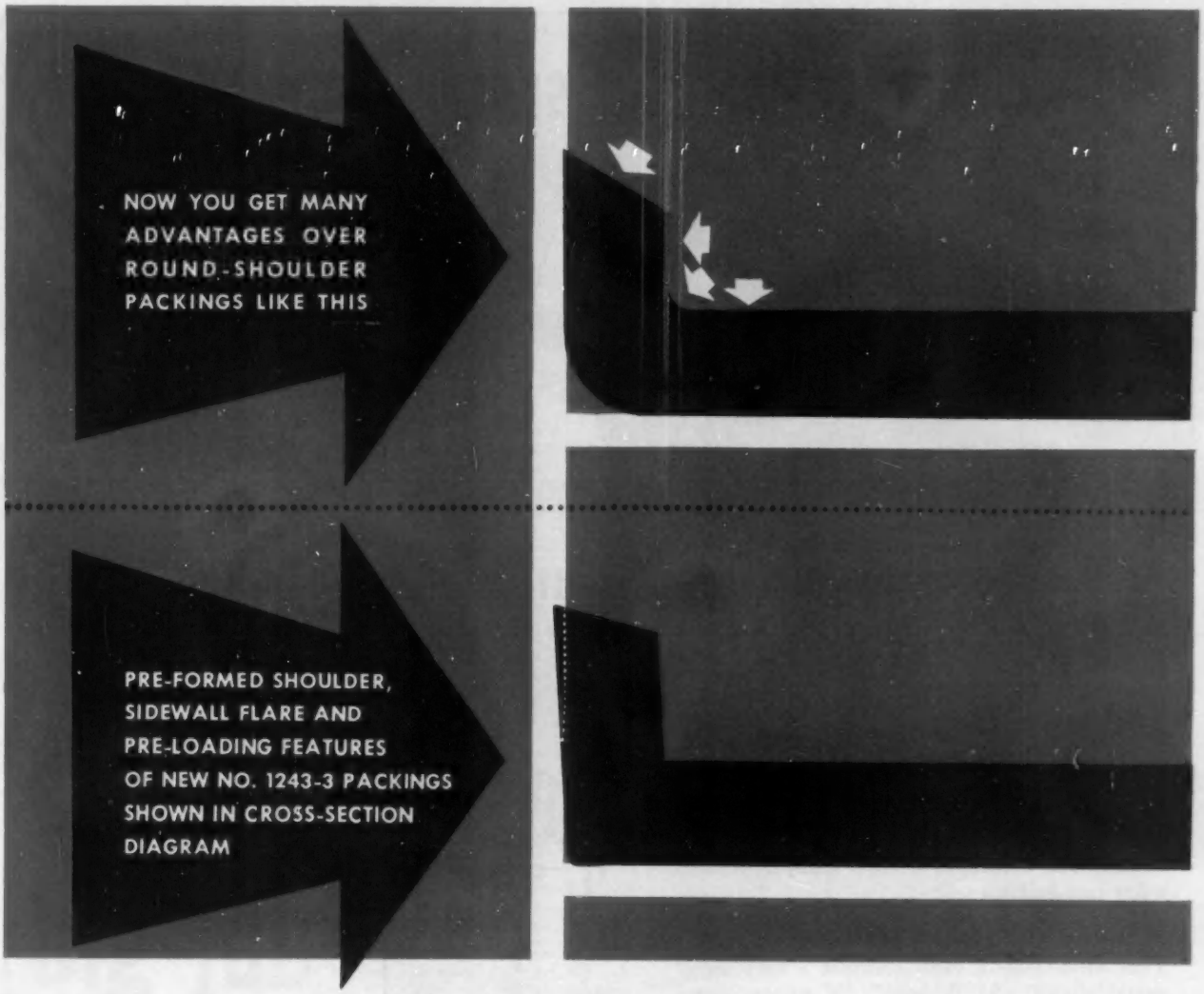
in high altitudes and sub-zero temperatures, Vulcan Electric Heating Units hold lubricants in a liquid state.

They're used also as anticipators in thermostatic control: in guided missiles and in speed indicators.

Vulcan electric heat is helping in many new inventions for both war and peace. To assist in the further development of your ideas, Vulcan heating designers will be glad to join their know-how to yours.

VULCAN ELECTRIC CO.
DANVERS 18, MASS.

Makers of Vulcan Electric Soldering Tools, Electric Solder Pots, Electric Glue Pots, Electric Branding Irons and Electric Heating Units.


NOW YOU GET MANY ADVANTAGES OVER ROUND-SHOULDER PACKINGS LIKE THIS
PRE-FORMED SHOULDER, SIDEWALL FLARE AND PRE-LOADING FEATURES OF NEW NO. 1243-3 PACKINGS SHOWN IN CROSS-SECTION DIAGRAM

Houghton's 1243-3 packing design solves 3 problems at once!

LOOK WHAT VIM NO. 1243-3 PACKINGS . . . pre-formed and pre-loaded . . . will do for you:

FIRST, leaks at low pressure are eliminated!

SECOND, packings won't rupture at top pressures!

THIRD, friction will be substantially reduced!

It's rather revolutionary, this Houghton-developed idea of pre-forming packings. But years of use and testing have proved its benefits to you.

Our unique #1243-3 cup packings also upset the widespread idea that synthetic rubber can't be thoroughly impregnated in leather—to combine the advantages of both. Houghton packing engineers have done it!

You can imagine the superior resiliency, the lower coefficient of friction, the much tighter seal you get with our rubber-impregnated leather packings. Ask the Houghton Man for details, or write to Packing Research Dept., E. F. Houghton & Co., 303 West Lehigh Ave., Philadelphia 33, Pa.

VIM #1243-3 RUBBER-IMPREGNATED LEATHER CUP PACKINGS

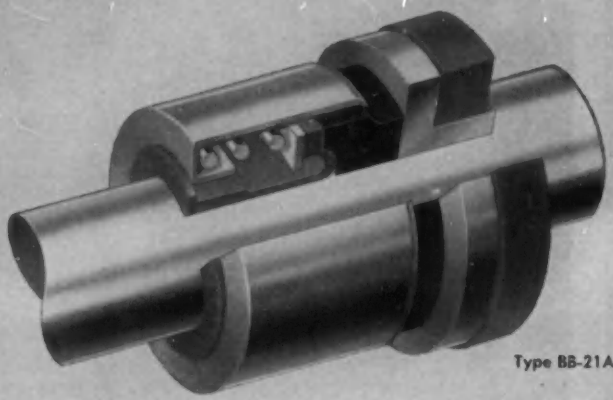
. . . a product of

E F HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

GARLOCK MECHANIPAK SEAL



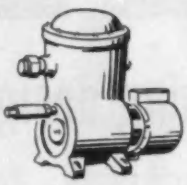
Type BB-21A

for Rotating Pump Shafts at pressures up to 150 p.s.i.

MAY IS NATIONAL WATER SYSTEMS MONTH

The Garlock BB-21A MECHANIPAK Seal, proven in service on thousands of water pumps, provides a low cost *leakless* seal.

IMPORTANT FEATURES



This MECHANIPAK Seal occupies a very small space—specifically designed for rotary pump shafts. It comes completely assembled, ready to install. Standard construction includes brass shell, brass washer and Buna-N bellows. Other materials available. Furnished for shafts from ⅜" to 3" diameters.

SAVE 3 WAYS

Customers tell us the MECHANIPAK Seal *pays for itself*. (1) Reduces maintenance costs (2) Absolutely no shaft wear (3) Cuts down time.

Get all the facts on this MECHANIPAK Seal. Write today for bulletin AD-150.

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N. Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ontario

GARLOCK

PACKINGS, GASKETS, OIL SEALS

MECHANICAL SEALS, RUBBER EXPANSION JOINTS

WE WANT KIBITZERS

Do you have any ideas on how we can make future issues of your Annual HANDBOOKS of *Product Design* even more useful to you? Many of the features in the 1955 issue particularly are the result of constructive suggestions from you. Other ideas our readers have offered are so comprehensive they require intensive study and preparation. Some of these suggestions already are in the works for the 1956 issue, to be published next October.

If you haven't checked your HANDBOOKS lately, here's a summary of the product engineering classifications they cover:

- General Engineering
- Metals and Alloys
- Non-Metallic Materials and Finishes
- Fabrication and Production Processes
- Power Transmission
- Mechanical Parts and Design Analysis
- Fastening and Joining
- Motors, Engines, and Controls
- Electrical and Electronic Components
- Hydraulic and Pneumatic Equipment

If you do not find the answers to your questions under these subject headings in the 1955 HANDBOOK, look at its cumulative editorial index, which coordinates the wide range of data available to you in *all three* HANDBOOK issues published to date.

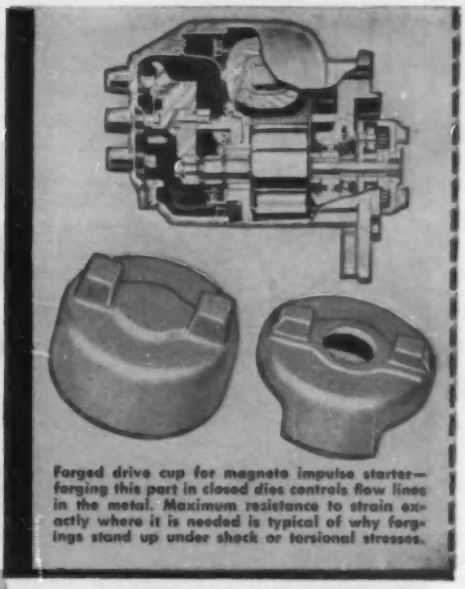
•

Product Engineering

McGraw-Hill Building, New York 36, N. Y.

Strength and safety are vital in rugged pole climbing service. Forged parts possess all the inherent qualities necessary for light weight design and performance stability.

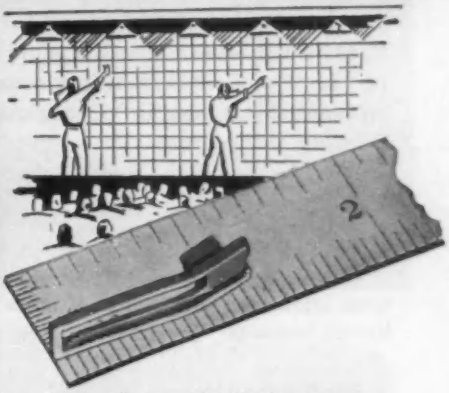
The exact size of this forged blade clamp on this versatile hand tool is 7/8" over-all width. Small forgings can be produced to exceptionally close tolerances—which means economical production with the highest obtainable degree of toughness and strength.



Forged drive cup for magneto impulse starter—forging this part in closed dies controls flow lines in the metal. Maximum resistance to strain exactly where it is needed is typical of why forgings stand up under shock or torsional stresses.

SMALL FORGINGS THAT DO A big job

Engine cowl and mounting bracket are typical of how lighter and thin sectional parts maintain the strength-to-weight ratio by forging.



A unique forging, only 1 3/16" long, does an important job as used in a stock exchange indicator. Subjected to direct impact load each second, it is required to last 20 years.

Forged parts, regardless of size, yield the combined advantages of strength, a greater factor of safety, and shock-resistance. The smallest of forged parts requiring important functional and precision demands more than meet desired specifications—*a major importance to your product application.* Consult a forging engineer. His experience will be helpful to you with your part design analyses—he symbolizes service without obligation.

DROP FORGING ASSOCIATION
605 Hanna Building
CLEVELAND 15, OHIO

This book tells why forgings are used for the toughest work loads. Engineering, production and economic advantages obtainable with closed die forgings are presented in this reference book on forgings. Write for copy today or attach coupon to your business letterhead.

A new full color 33 min., 16 mm. Movie entitled, "Forging in Closed Dies," reveals all aspects of the closed die forging process of forming parts. Represents over ten years of planning and research. The film is effective before many types of audiences, including technical societies, college engineering classes, purchasing agents, and similar groups. Write for information about loan of film without cost.

DROP FORGING ASSOCIATION
605 Hanna Bldg., Cleveland 15, Ohio

Please send 64-page booklet entitled, "Metal Quality —How Hot Working Improves Properties of Metal" 1953 Edition.

Name .....
Position .....
Company .....
Address .....

How About Pearlitic Malleable ?

Specify Pearlitic Malleable Castings

FOR STRENGTH WEAR RESISTANCE MANUFACTURING ECONOMY

Pearlitic malleable is a specially processed malleable iron. It possesses an unusual combination of toughness, ductility and machinability.

Small Engine Crankshaft

- Pearlitic malleable has exceptional bearing properties—in many applications allows the elimination of brass or bronze bushings.

Automotive Rocker Arm

- Pearlitic malleable has high yield strength, from 45,000 to 80,000 psi to meet your requirements.

Diesel Engine Piston

- Pearlitic malleable is easily machined and has excellent finishing qualities—readily acquires a smooth mirror-like finish.

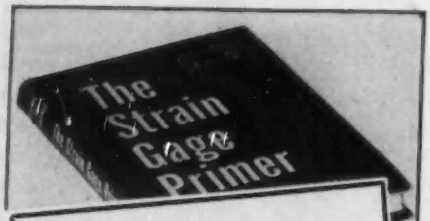
Universal Joint Yoke

- Pearlitic malleable can be selectively hardened by flame, induction or immersion methods for even greater wear resistance.

Write to the Malleable Founders' Society for names of foundries that make pearlitic malleable castings and for complete specifications.

Malleable FOUNDERS' SOCIETY

1800 Union Commerce Building **Cleveland 14, Ohio**



How to use STRAIN GAGES

- in developing new designs
- improving old designs
- determining service loads
- and as efficient transducers

JUST OUT!

WHAT this versatile instrument can do in solving hundreds of problems in experimental stress analysis is thoroughly explained in this complete and practical handbook on the bonded wire resistance strain gage. All phases of the subject are covered—from selecting the proper commercial gage, through preparing the surface of the test member, cementing, damage-proofing, and wiring the gage, to selecting the proper instrument to record the strain gage data, and interpreting the readings in terms of significant stresses.

In addition, the book outlines a whole new field of application for this device—its use as a transducer element for instrumenting and controlling countless mechanical variables such as force, speed, load, torque, and pressure.

The STRAIN GAGE PRIMER

By C. C. PERRY
Assistant Professor of Engineering Mechanics, Wayne University and Research Consultant
and H. R. LISSNER
Professor and Chairman, Department of Engineering Mechanics, Wayne University

280 pages, 6 x 9, 180 illustrations, $6.00

IN this book, you have a detailed treatment of strain gages explained in everyday language and with a minimum of mathematics. Covered in practical fashion are what these simple and enormously helpful devices can do in scores of applications, plus step-by-step directions for using strain gages and interpreting the derived data. The facts are presented in a manner that makes it easy for you to start using strain gages at once in your work.

Newer types of American and foreign gages are described in addition to advances made in overcoming problems of extreme operating conditions for strain gages. Finally, you have a practical introduction to the use of brittle lacquer coatings, and how they are used together with strain gages for more accurate determination of stresses and strains.

13 practical chapters . . .

• *An Introduction to Strain Measurement* • *Bonded Wire Strain Gage* • *Basic Strain Gage Techniques* • *The Wheatstone Bridge* • *Instrumentation* • *Strains and Stresses* • *Strain Rosettes and Stress Gages* • *Moisture-proofing of Strain Gages* • *Long-time Strain Gage Installations* • *The Use of Strain Gages with Slip Rings and Switch Contacts* • *Transducer Applications of Strain Gages* • *Special Problems, Techniques, and Applications* • *Strain Indication with Brittle Coatings* •

10 DAYS' FREE EXAMINATION

McGRAW-HILL BOOK CO., Inc., Dept. PE-5
330 W. 42nd St., NYC 36

Send me Perry and Lissner's **THE STRAIN GAGE PRIMER** for 10 days' examination on approval. In 10 days, I will remit $6.00, plus few cents for delivery costs, or return book postpaid. (We pay delivery costs if you remit with this coupon; same return privilege.)

PRINT

Name .....

Address .....

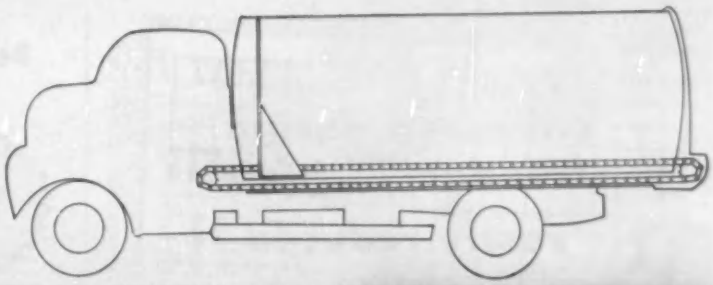
City .....Zone....State.....

Company .....

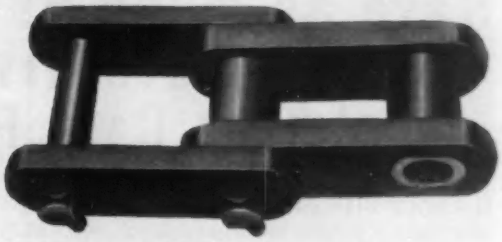
Position .....

For price and terms outside U.S., write McGraw-Hill Int'l., NYC. PE-5

Pak-Mor refuse collection units are sanitary, large-capacity models. Diagram shows how Jeffrey chain moves packer plate—applying power from truck power takeoff. Below is 20 cu. yd. Pak-Mor unit mounted on a Ford COE chassis.



JEFFREY chain packs more power



Jeffrey Steel Knuckle Chain
Straight Side Bar Type

Pak-Mor Manufacturing Company, San Antonio, Texas, had a special problem: They wanted a powerful, long-lasting chain to drive the packer plate in their refuse collection units.

Jeffrey engineers designed a steel knuckle chain for the job. It transmits the truck's own power, through a power takeoff and gear reducer, to compress rubbish and garbage in the truck and then eject it at the disposal site.

Pak-Mor and Jeffrey have worked as a team for more than ten years now. High quality chain helps Pak-Mor units make longer collection trips, saving money for cities and towns . . . and in turn the people of the community.

Jeffrey design and production experience are ready to work for you, too, on any of your power transmission or conveying problems. Send your problem to our Merchandise Sales Division today.

THE JEFFREY MANUFACTURING CO.

ESTABLISHED 1877

Columbus 16, Ohio

sales offices and distributors in principal cities

PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

IF IT'S MINED, PROCESSED OR MOVED
. . .IT'S A JOB FOR JEFFREY!

Save as much as 67% with intricate Arwood Investment Cast Parts

It is now possible, with the Arwood investment casting process, to economically produce shapes impractical to obtain by conventional methods. Often, many assemblies can be combined into a single casting, using unmachinable alloys. Applications are virtually unlimited.

Our engineers will be pleased to go over your parts problems with you and help cut your own costs. Why not submit parts or prints to us for quotations? Consultation is free of obligation, of course.

Write for free literature describing the investment casting process.

CASE STUDY

DESIGNATION: Aircraft emergency door latch.
METAL: Stainless steel 410 (AMS 5350).
PARTS: Designed and cast as a single unit.
QUALITY CONTROL: Produced under X-ray control. Chemical and physical affidavits furnished. Test bars submitted.
ADVANTAGES: Investment casting, by eliminating all finishing operations except reaming of cast hole through pivot boss, reduced cost from over $10.00 each to approximately $3.50 each.

ARWOOD

PRECISION CASTING CORP.

68 WASHINGTON STREET • BROOKLYN 1, N. Y.

PLANTS: Brooklyn, N. Y. • Groton, Conn. • Tilton, N. H. • Los Angeles, Calif.

Design for Low Control Cost . . .

ARENS "Seven Standards" may help you save money.

ARENS PUSH-PULL CONTROLS

Low in price, easy to install, there are seven standard Arens designs to meet light, medium and heavy load requirements. They are available with a variety of control heads, casings, and end fittings. Special controls can also be designed to meet specific requirements. Design with Arens Controls in mind . . . and save.

Write for Catalog

ARENS CONTROLS, INC.

2013 Greenleaf Street, Evanston, Illinois

FOR Quality Performance from
WIRE FORMS
SPRINGS
METAL STAMPINGS
Rely on
DUDEK & BOCK
You get precision WIRE FORMS, Springs and Stampings that are easily assembled . . . that withstand stresses . . . perform under the most *trying* conditions. Rely on our free designing service. Our EXPERT ENGINEERS will produce design that meet your *exact* needs—and save you MONEY!
Valuable FREE Brochure
SPEEDY DELIVERY
WRITE—WIRE or PHONE
for Estimates and Delivery Dates
Phone:
DICKENS 2-1020
DUDEK & BOCK
SPRING MFG. CO.
4014 W. Grand, Chicago 51, Ill.

This is the **PAYOFF**...
when you're carrying **PAYLOADS**

First cost doesn't mean much when you're talking about truck trailers or railroad coaches made of Allegheny Metal. In such uses, this time-tested stainless steel begins to pay you back right away. It's so strong that there's far less dead weight, and correspondingly more payload. It saves on maintenance—it saves on fuel . . . and *no other metal* can match stainless steel for ability to take a beating, laugh off corrosion and last almost infinitely in service.

In fact, wherever you use it, stainless costs you less in the long run . . . pays you a profit. There's many an advantage waiting for you in Allegheny Metal—let us help you secure them. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania.***

Make it BETTER-and LONGER LASTING-with
Allegheny Metal

AL® TIME-TESTED STAINLESS STEEL

WAD 5306 B **Warehouse stocks carried by all Ryerson steel plants**

VIBRATION-DAMPING

SHOCK-ABSORBING

SKID-PROOFING

CUSHIONING

NOISE-KILLING

SCRATCH-PREVENTION

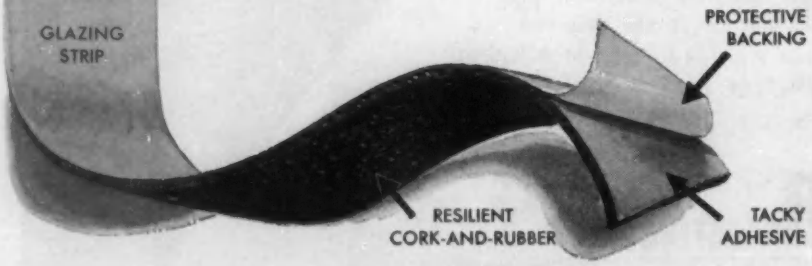
GLAZING STRIP

Vibration-damping

Appliance feet made of Armstrong DK-153 Tape isolate and damp disturbing vibration . . . make appliances run smoother, quieter. In addition, this resilient, cork-and-sponged-rubber material prevents marring of floor, table, and counter surfaces.

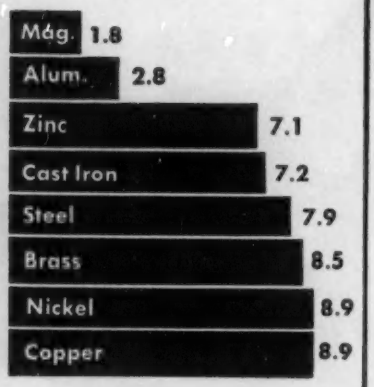
You'll find it easier to design economical feet for appliances with Armstrong DK-153 Tape. This adhesive-backed material can be die-cut to any shape and attached quickly to most clean, dry surfaces. No mechanical fasteners are needed . . . no special materials. Just peel off protective cloth and press tape into place.

You can order DK-153 in tapes, sheets, rolls, or die-cut shapes in a variety of thicknesses. For samples, write on your letterhead to Armstrong Cork Company, Industrial Division, 7305 Irvin Street, Lancaster, Penna.



Armstrong DK-153 TAPE

TABLE OF COMPARATIVE WEIGHTS
(Specific Gravities)



Reducing the Weight of Assemblies?

This teleprinter cover, deep-drawn from .065" thick magnesium, weighs only 3 lbs. 13 oz. If it were made of steel, it would weigh almost 18 lbs.; or of aluminum, about 5¾ lbs.

In a wide range of products such as housings and covers, direct gauge-for-gauge substitution is often possible.

Magnesium gives you lightness plus excellent drawability.

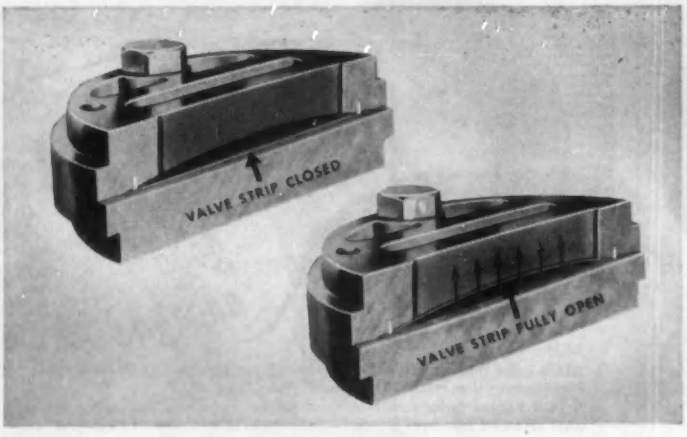
B&P engineers will help you redesign in magnesium. B&P offers the magnesium industry's most complete facilities for fabrication and assembly. Your inquiry will bring a descriptive booklet.

BROOKS & PERKINS, INC.

1956 West Fort Street
Detroit 16, Michigan

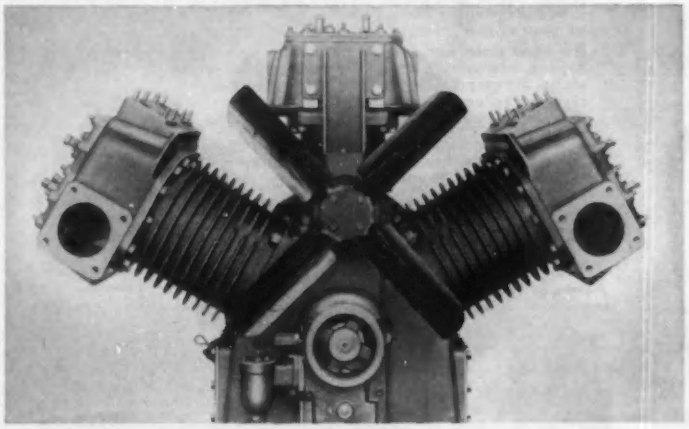
WHAT'S YOUR C.Q.*?

*COMPRESSOR QUOTIENT



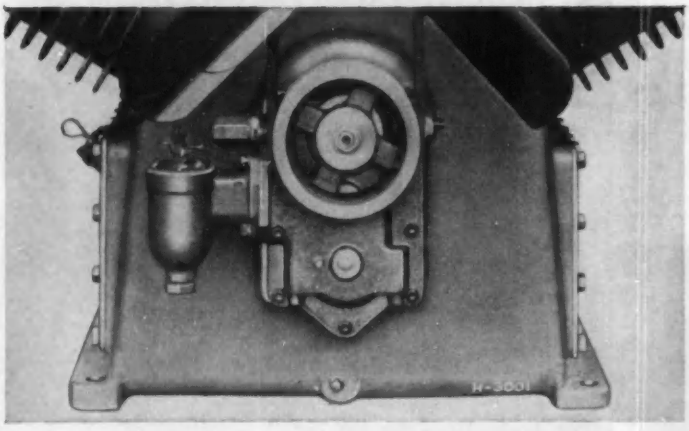
What's the lightest-acting air compressor valve made?

No doubt about this one — it's Worthington's exclusive Feather* Valve. Responsive as a feather to air flow, it can open, release air and close in one-hundredth of a second—with no back-leaking and efficiency losses. You can get more information about the Feather Valve by writing for Bulletin L-675 S12.



How can you get effective air cooling of air compressors?

Fan-cooling of isolated cylinders is the answer. In Worthington Radial and Balanced Angle air compressors, cooling air flows completely around the isolated cylinders. And the high-capacity fan blows air directly over upper parts of cylinders and cylinder heads — where heat is greatest. Our Bulletin H-630-B1 tells you more about Worthington Radial air-cooled air compressors.



What's the modern way to lubricate an air compressor?

The right answer is force-feed lubrication—with continuous full-flow oil filtration. And that's exactly what you get in Worthington Radial Air Compressors (and *only* Worthington, by the way). Result: less bearing wear, less oil pumping, longer cylinder life and lower lubricating oil cost. One twist of the handle cleans the Cuno filter without stopping flow. Read Bulletin H-630-B1 for more facts. PC.5.3

Reg. U.S. Pat. Off.

Write today for bulletins to Worthington Corporation,
Section PC.5.3, Harrison, N.J.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Air Compressors • Pumps • Multi-V-Drives • Allspeed Drives

Everybody talks about Service

at "CHICAGO" we DO something about it!

The word "Service" is abused by many suppliers. Here at "Chicago" it means action — faster deliveries, whether it be a package or a carload.

● From over 4,000 standard catalogued items *in* stock your shipment is on its way within 24 hours — often sooner.

● There is no time consuming follow-up necessary to see what's happened to it.

That is why so many industrial users in the last 83 years have come to specify "Chicago" Screws . . . service is faster . . . quality is better . . . it costs less to do business with us because no large inventories are necessary.

Service-conscious Industrial Supply Distributors EVERYWHERE carry complete stocks of "CHICAGO" Products. To speed delivery time, call the one nearest you.

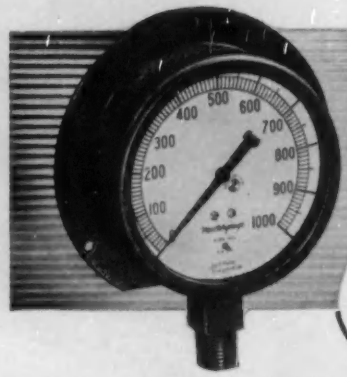
CHICAGO SCREWS

The CHICAGO SCREW COMPANY
ESTABLISHED 1872
2507 Washington Boulevard
Bellwood, Illinois

402

The complete Chicago "Safety Plus" line includes in alloy steel: Socket Set Screws • Socket Head Cap Screws • Socket Stripper Bolts • Square Head Dog Point Set Screws • Socket Pipe Plugs • Flat Head Socket Cap Screws • Dowel Pins • Hexagon Keys and Key Kits • Also Socket Set Screws and Socket Head Cap Screws in Stainless. The complete "Chicago" line of Standard Products includes: Hexagon Head Cap Screws in steel—bright and Grade 5, heat treated, also in brass and stainless • Square Head and Headless Set Screws • Taper Pins • Steel Studs Flat and Fillister Head Steel Cap Screws • Hexagon Nuts in steel, brass and stainless.

MARSH *Mastergauge*



where only the best is good enough!

Always the best of the better gauges, Mastergauge has been given *plus* features that further lengthen its lead.

A still better tube construction: Socket, tube and end piece are now all fused into *one* leak-tight unit by the new Marsh "Conoweld" process.

A still better case: New copper clad wrought steel "Marshalloy" case has the corrosion resistance of pure copper; weighs one third as much as cast iron, and is *four times* as strong.

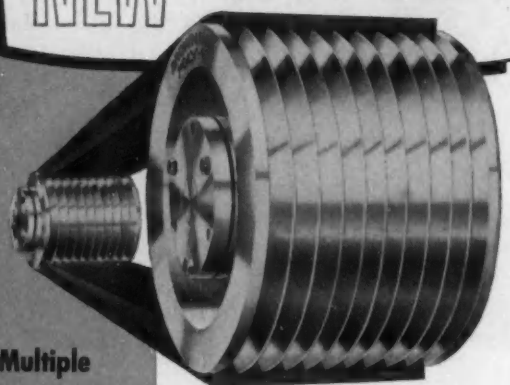
An even finer movement: Further refinements are added to the rugged, corrosion resistant, virtually frictionless stainless steel and monel Mastergauge movement. A typical refinement is the "coined" (extruded) sector gear which contributes extra strength and precision.

Where only the best is good enough—in the most critical industrial refinery and oil country services —"Mastergauge" is your instrument.

WRITE FOR NEW CATALOG

MARSH INSTRUMENT CO. Sales affiliate of Jas. P. Marsh Corporation
Dept. 39, Skokie, Ill.
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alta.

NEW **BROWNING POLY-V* DRIVE**



Multiple V-Belts in a Single Unit

This remarkable new drive consists simply of rows of parallel V-belts molded as a single unit, running on matching sheaves. Its advantages are:

- Save space—narrow sheave faces, small diameters
- Reduce bearing pressures
- No matching of separate V-belts
- Maximum horsepower in minimum space

Ask your Browning distributor or write us for Bulletin 2098.

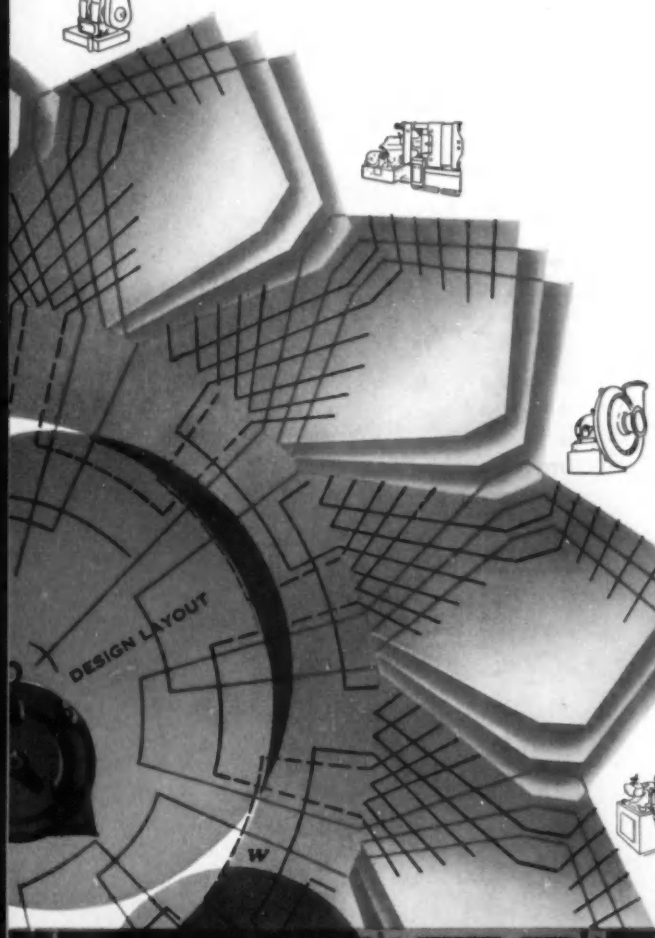
**Raybestos-Manhattan, Inc. registered trademark for its patented Poly-V Drive.*

Browning MANUFACTURING COMPANY
MAYSVILLE, KENTUCKY

THE MARK OF AN EXTRA DEPENDABLE MACHINE

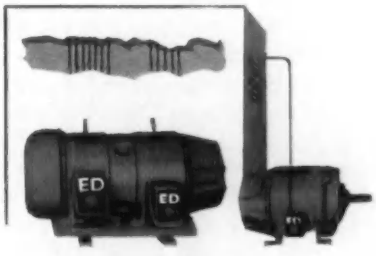
ED ELECTRO DYNAMIC

75TH ANNIVERSARY 1880 — 1955



A BETTER KIND OF POWER PACKAGE

Extra starting and anti-stalling capacity. Extra cool, extra quiet operation. Achieved without sacrifice of full-load efficiency. Backed by unparalleled experience E. D. motors are *extra dependable*...75 years in the making...yours today *at no extra cost!*



"Selectrol" Variable Speed Drives for *extra dependable* automation.

Gear-ED-motors offer a wide choice of speeds.

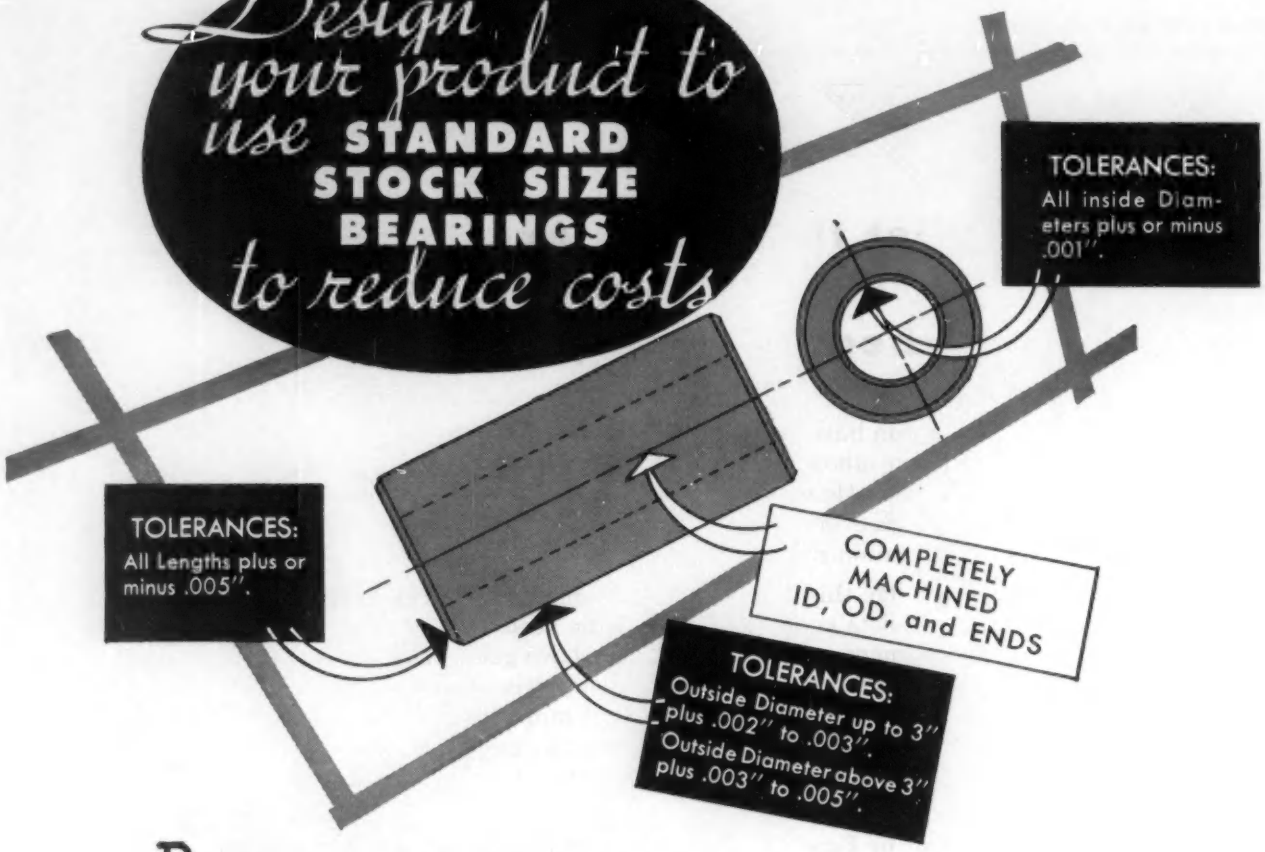
ELECTRO *Extra* **DYNAMIC** *ependable motors*

PRODUCT OF GENERAL DYNAMICS

GD GENERAL DYNAMICS | ED ELECTRO DYNAMIC | EB ELECTRIC BOAT | GA GENERAL ATOMIC | C-L CANADAIR LIMITED | C-V CONVAIR

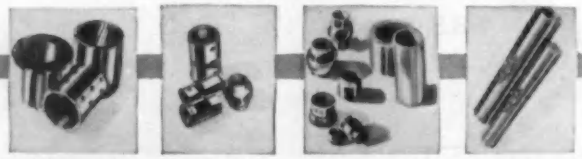
1500 Write for literature to: **ELECTRO DYNAMIC** DIVISION OF GENERAL DYNAMICS CORPORATION, BAYONNE, N. J.

Design your product to use STANDARD STOCK SIZE BEARINGS *to reduce costs*


TOLERANCES:
All inside Diameters plus or minus .001".
TOLERANCES:
All Lengths plus or minus .005".
COMPLETELY MACHINED ID, OD, and ENDS
TOLERANCES:
Outside Diameter up to 3" plus .002" to .003".
Outside Diameter above 3" plus .003" to .005".

PERHAPS only a slight change in product design is necessary to use stock size Johnson GP Cast Bronze Sleeve Bearings. If so, you can cut costs on this item. There are inside diameters available from ¼ inch to 4½ inches, with a selection of wall thicknesses and lengths—over 900 individual sizes. Even if you require slight alterations, slots or oil grooves, the cost still will be much less than for specially made bearings. Many leading manufacturers have adopted stock size Johnson GP Bearings and saved time and money. They are available from your local Johnson Distributor's stock. The Johnson Bearing Catalog lists all stock items . . . write for your copy today.

JOHNSON BRONZE COMPANY
508 South Mill Street, New Castle, Pa.



GRAPHITED CAST BRONZE | ELECTRIC MOTOR | LEDALOYL Self-Lubricating | UNIVERSAL BRONZE BARS

JOHNSON JB BEARINGS
Sleeve-Type

JOHNSON
GP *general purpose*
BEARINGS

OVER 900
sizes in stock at
your local distributor's

Get this Motor Application Help...

it begins when you start

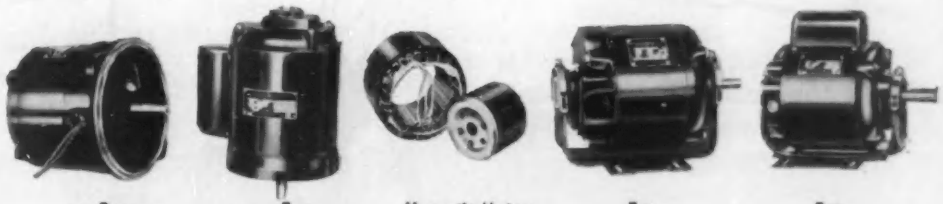
You can have an Emerson-Electric power-drive specialist right at your elbow the moment you start working on any design problem. He will stay with it to the "end of the line"—follow through every stage from development to final test and application runs.

Help like this is especially valuable because Emerson-Electric specialists know motors AND the needs of appliance and equipment manufacturers. They have gained their knowledge through 65 years of meeting motor-drive requirements—beginning in 1891, when the first motor was produced to operate a sewing machine. Since this early date, their accumulated experience has covered 38 different fields; a few are listed at the left.

Profit by Emerson-Electric's years of experience and the combined ability of its motor specialists. They know motors AND the appliance and equipment business.

EMERSON-ELECTRIC SUPPLIES MOTORS FOR APPLIANCES AND EQUIPMENT IN THESE CLASSIFICATIONS

Beauty Shop
Farm
Heating and Ventilating
Laundry
Medical
Musical
Office
Printing and Typesetting
Pump
Recording
Refrigeration
Scientific
Store



For Oil Burners | For Pumps | Hermetic Motor Parts | For Laundry Equipment | For Blowers

Write THE EMERSON ELECTRIC MFG. CO., ST. LOUIS 21, MO., for Bulletins listed below

- ☐ M 4007-A Capacitor-Start
- ☐ M 4007-B Split-Phase
- ☐ M 4007-C Integral
- ☐ M 4007-D Fan Duty
- ☐ M 4007-E Oil Burner
- ☐ M 4007-F Jet Pump
- ☐ M 4007-G Blower

Emerson-Electric of St. Louis • Since 1890

Branches

New York 17, N. Y., 420 Lexington Ave. • Chicago 23, Ill., 1623 S. Pulaski Road • Syracuse, N. Y., 209 Oakley Drive • Detroit 7, Mich., 1375 E. Jefferson Ave. • Los Angeles 42, Cal., 5415 York Blvd. • Davenport, Iowa, 617 Brady St. • Cincinnati, Ohio, 2917 Ratterman Ave.

Perkins ...

"Custom tailors" to cost-conscious Design Engineers

WHETHER that cost is "first" or "operating" it will pay dividends to investigate the saving possibilities of having the gears in your products custom-made by PERKINS — one of New England's oldest and ablest gear-engineering organizations.

PERKINS MAKES:

to customers' specifications, in all materials, metallic and non-metallic: bevel gears, ratchets, sprockets, ground thread worms, spiral gears, helical gears, spur gears with shaved or ground teeth.

NOTE: The PERKINS PRECISION SPRING COILER is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want when you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire sizes .005 to .125. Diameter, from 3/32" to 12" and larger. Size of the compact coiler is only 7 1/2x16". A POWER MODEL is available. Information on request.

Perkins Machine & Gear Company

105 Circuit Avenue

WEST SPRINGFIELD, MASS.

IT TAKES TWO

DISPLAY ADVERTISING

- **AROUSES INTEREST**
- **CREATES PREFERENCE**

DIRECT MAIL

- **GETS PERSONAL ATTENTION**
- **TRIGGERS ACTION**

After your prospect has been convinced by DISPLAY ADVERTISING, he still must take one giant step. *He must act.* A personalized mailing piece direct to his desk, in conjunction with a display campaign, is a powerful action getter.

McGraw-Hill has a Direct Mail Division ready to serve you with over 150 specialized lists in the Industrial field.

To get your copy of our free INDUSTRIAL DIRECT MAIL CATALOGUE (1954) containing complete, detailed information about our services, fill in the coupon below and mail it to McGraw-Hill.

Do it now! The best advertising programs are planned well in advance.

Direct Mail Division,
McGraw-Hill Publishing Co., Inc.
330 West 42nd St., N. Y. 36, N. Y.

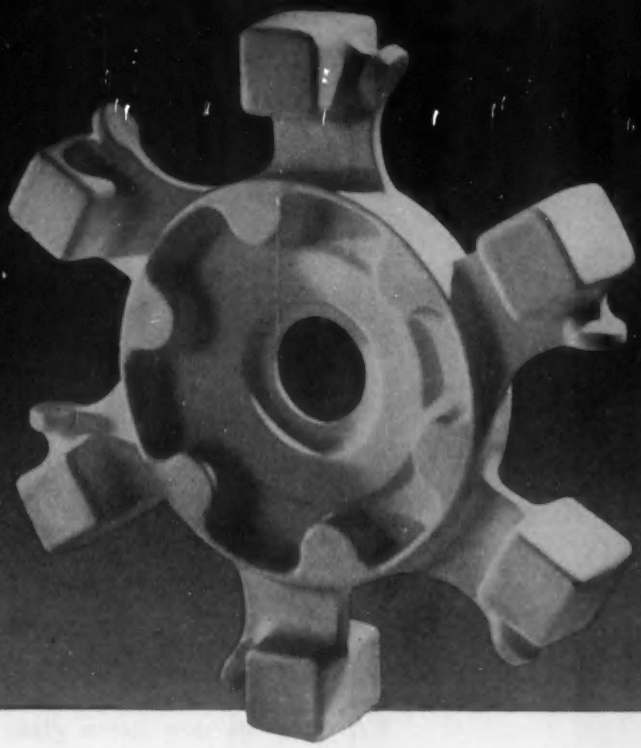
Please forward my free copy of the McGraw-Hill "Industrial Direct Mail Catalogue."

Name_____

Company_____

Address_____

City_____ State_____



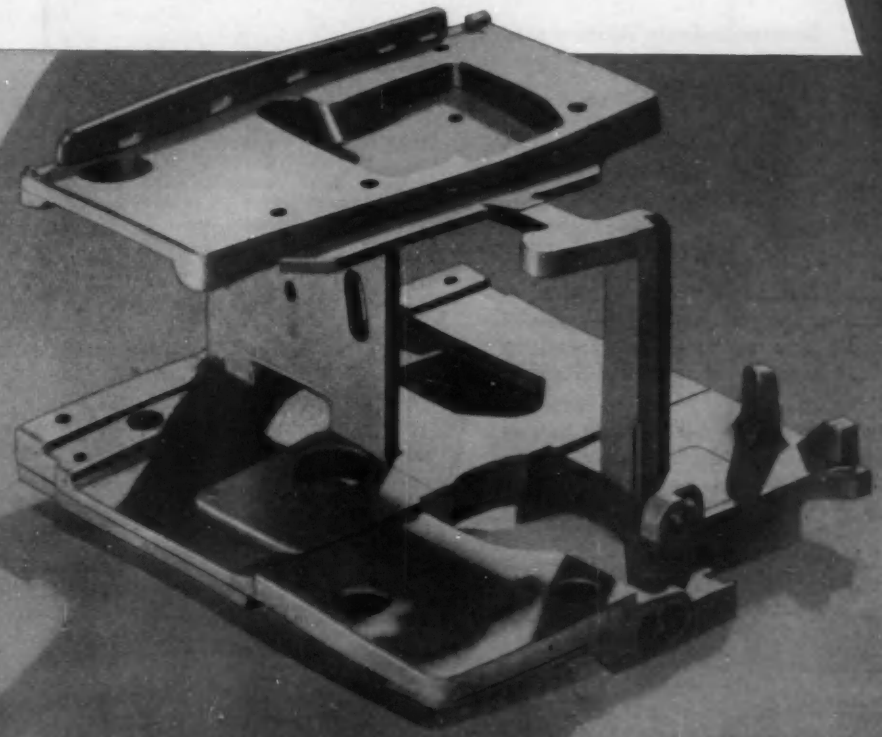
Hiduminium

makes the most of *Aluminium*

Hiduminium Forgings and Die Castings for all industries.

HIGH DUTY ALLOYS LIMITED. AGENTS: RUSSELL ASSOCIATES INC.

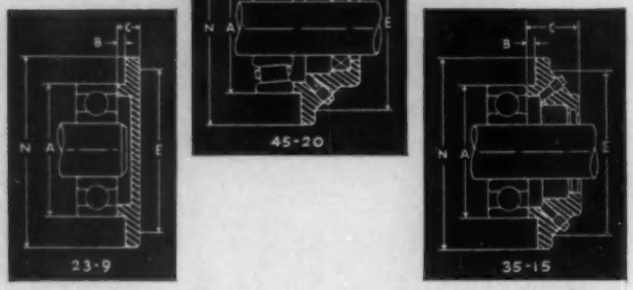
165 ORINOCO DRIVE, BRIGHTWATERS, L.I., N.Y.



FREE

YOUR PLANT EQUIPMENT
FROM
"NUISANCE" SET-UPS

STANDARDIZE with B-A BEARING COVERS!



Descrip-tion	"A" Bearing O.D.	"B" Depth Rabbet	"C"	"E" Bolt Circle	"N"	No. and Size Bolts	Shaft	O.D. Oil Seal
#23-9	2.2500	1/8"	7/16"	3"	LUG TYPE	4 3/8"	—	—
#45-20	5.0000	3/16"	2 1/4"	6"	7"	6 1/2"	2 1/8"	3.555
#35-25	6.2992	1/4"	2 1/16"	7 1/2"	8 3/16"	6 5/8"	3 1/16"	FELT 1/8" x 1/16"

Savings aplenty when you standardize with B-A Standard Bearing Covers!

NO MORE "nuisance" set-ups!

NO MORE costly designing, drafting, detailing of your individual bearing covers!

NO MORE costs for patterns, jigs, fixtures, gages, etc.

. . . Just simply standardize with B-A Bearing Covers . . . in 14 sizes, 12 types, three depths. They fit all standard size ball and roller bearings—approved by all leading bearing manufacturers.

NEW! Booklet on B-A Standard Bearing Covers . . . yours for the asking! Contains much informative design data.

B&A STANDARD BEARING COVERS

BEARING APPLIANCE CO.
5823 GREENE STREET
PHILADELPHIA 44, PA.

to a man who *Thinks* he knows glass-to-steel hermetic terminals

If you're a guy who thinks you must buy a bulky beefed-up terminal to get top performance like 100,000 Megohms at 150° C. it's because you haven't yet accepted our suggestion to test Fusite's new Torture-Proof Terminals with V-24 glass.

This brand new green glass makes possible greatly improved performance, but retains the famous Fusite light weight cap.

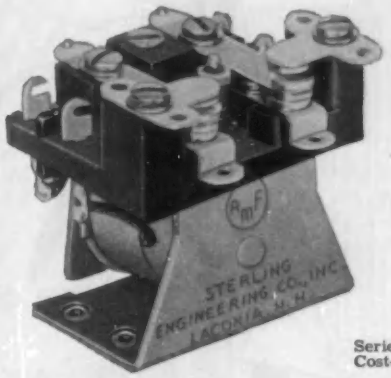
All we ask is that you let us send you samples without obligation for testing under your own conditions. We know you will find extreme resistance to thermal and mechanical shock and greatly improved flash-over. These terminals are hot solder dipped for salt spray resistance and easy soldering.

Specify Fusite V-24 glass in the samples you request.

FUSITE TERMINALS

Write Dept. Q-2

THE FUSITE CORPORATION
6000 FERNVIEW AVENUE
CINCINNATI 13, OHIO

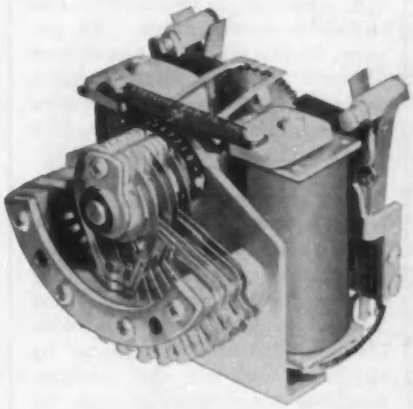


Series PS—Heavy Duty Power—Low Cost—High Quality AC or DC Relay.

SIMPLE OR COMPLEX DESIGN

Sterling

has the answer



Series SS—Bi-Directional Stepping Switch—Direct Current Actuated.

Sterling Engineering is daily designing and producing products from *Simple Single Spring* relays to *Complex Multi-Spring* Bi-Directional Stepping Switches.

The PS Series of relays—one of the many built to the high quality standards of all Sterling products is *priced lower* than competitive relays and are in stock for *immediate shipment.*

The Series PS heavy duty power relay, is small in overall dimensions, only 1⅝" x 1⅞" x 1$\frac{13}{32}$" high, yet has a contact capacity up to 20 amperes. Available in any operating voltage to 230 AC or 220 DC.

Type SS Bi-Directional Stepping Switch is a new conception in magnetically actuated devices. The output shaft may be operated in either direction to drive the wipers or as a Stepping motor to drive potentiometers, servo mechanisms or other control devices. In computer applications it is a converter from digital to analog or vice versa.

The contact banks can easily be removed from the driving unit without disturbing the switch adjustments, thus making easy bench wiring or field service.

Type SS can be equipped with up to 4 switch banks, each with up to 12 positions and each set of contacts will carry up to 3 amps.

Write:
Sterling Engineering Co., or
Potter & Brumfield Mfg. Co.,
Princeton, Indiana

Another AMF Product
Sterling RELAYS

happy solution to your

AXLE SHAFT

problems...

"Custom-Engineered"

US AXLE SHAFTS

WHATEVER your requirements in special shafts, U. S. Axle can produce them to your most exacting specifications—promptly and economically. Our huge modern plant is fully equipped for volume precision manufacture, backed by 35 years of *specialized* "know-how" in making the finest quality shafts for automotive and industrial applications. Any size . . . any type . . . made of toughest alloy steels for maximum durability and efficiency in your product.

Send us your blueprints and specs for prompt quotation on a "Custom-Engineered" U. S. Axle Shaft to meet *your* needs.

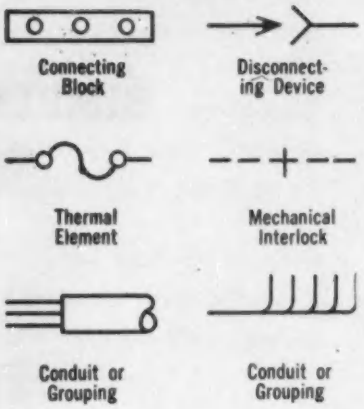
Write for this colorful illustrated folder today!

"THE WORLD TURNS ON U. S. AXLES"

THE US AXLE COMPANY, INC.

Since 1920 • Pottstown, Pennsylvania

Make THIS Your Standard for Electrical Symbols and Standards



Now you can help achieve industry-wide agreement on graphical symbols for electrical components. As you know, different groups have in the past advanced various proposals for standardization. But while many suggestions had merit, often forgotten was the fact that the symbols must be simple.

For this reason we have collected and reprinted, in an easy-to-use folder, the simplest-to-draw and most readily understandable symbols available. They are based mainly on the Engineering Drafting Standards of the Ford Motor Company, and are supplemented by standards data from the American Standards Association and from the National Machine Tool Builders Association.

To order a supply of these folders for you and your associates, write or call our Reader Service Department today. Copies are only 15¢ each.

Product Engineering

McGraw-Hill Building
New York 36, N. Y.

This NEW nylaflow* tubing saves money from beginning to end

NYLAFLOW . . . the new POLYPENCO® nylon tubing . . . now promises a new kind of performance in pressure lines for lubricants, air, fuel and oil, coolants, process streams, and hydraulic fluids. NYLAFLOW tubing is flexible, resilient and tough. It also resists abrasion and corrosion. Yet, it is economical to use from beginning to end.

FIRST COST OFTEN LESS

Available with a tested bursting strength of 1,000 psi or 2,500 psi, NYLAFLOW tubing costs less in some small sizes than copper tubing. It also costs substantially less than flexible rubber hose of comparable bursting strength.

COSTS LESS TO INSTALL

Flexible NYLAFLOW tubing does away with pre-bending, intermediate fittings, and the need for flexible hose attachments. It can be run in continuous lengths and connected simply by using a standard metal compression or flare fitting at each end. What's more, it's available in colors for color coding.

COSTS LESS IN THE END

Laboratory and field results indicate that NYLAFLOW should outlast other tubing in many applications. For example, NYLAFLOW stands up against constant rubbing, flexing, and vibration. It also absorbs hydraulic hammering and bumping.

SEND FOR NEW *NYLAFLOW* TUBING BULLETIN

THE POLYMER CORPORATION of Penna. • Reading, Penna.

POLYMER *NYLAFLOW* TUBING

. . . nylon . . . Teflon† . . . and other non-metallic shapes

In CANADA: Polypenco, Inc., 2052 St. Catherine W., Montreal, P.Q.

†Teflon is the trademark for DuPont tetrafluoroethylene resin

*NYLAFLOW is the trademark for The Polymer Corporation's nylon tubing

RITCO Forgings, in steel or non-ferrous metals, are clean, bright, accurate, and strong. Made in weights from ¼ lb. to 15 lbs., they have maximum strength for their weight. Parts are smooth, free of flash, and conform to your blueprints. Use RITCO Drop Forgings: They're the economical, right answer to your design problems. Send blueprints and specifications for free estimates.

We offer complete machining and grinding facilities for finishing forgings.

We also make special fasteners and finished bolts with regular or heavy heads. Exclusive New England representatives for Cleveland Cap Screw Company.

RHODE ISLAND TOOL CO.
Since 1834
148 West River Street
Providence 1, R. I.

KRAISSL

* Since 1926 * In the application, design and mfg. pumps—separators—hydraulic accessories.

EQUIPMENT FOR FLUID POWER TRANSMISSION

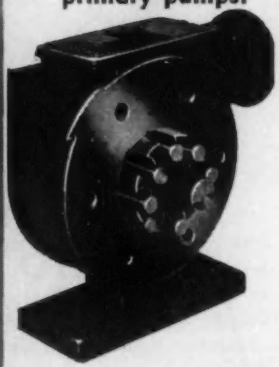
Primary
Oil Pumps
•
Vacuum
Powered
Transmission
and
Low
Pressure
Air Service
•
Air
and
Liquid
Filters
•

What's your problem?

√ higher pumping speeds?

√ tolerance of particle-laden liquids?

√ peak suction for primary pumps?



the Kraissl-50 Roller Pump

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller - rotor design easily handles particles that would jam more tightly - fitted mechanisms — reduce cavitation, allowing higher speed operation* — develops high suction characteristics.

** Roller mechanisms permit higher speeds with any oil than most displacement designs.*

KRAISSL CO Inc.
289 Williams Ave., Hackensack, N. J.

ANOTHER CENTRALAB *FIRST!*

NEW ISO-KAP*

Molded Disc Ceramic Capacitor

As precise as a fine watch

Nothing else like it! The only molded, *completely* insulated ceramic disc capacitor. Not merely a dipped covering—breakdown to ground in excess of 3000 V.D.C.

Highest mechanical strength. One-piece construction is unaffected by extremes of vibration; by ozone, salt water, or any known acid or solvent at room temperature.

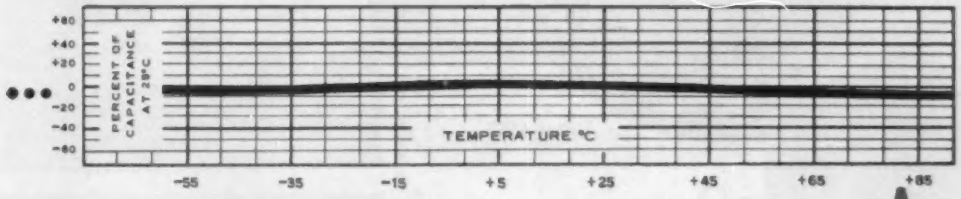
Mechanically accurate. Thickness, diameter, and lead spacing are always exact. And leads are always on perfect center line—never offset. The answer for automatic assembly.

Highest dependability. New basic ceramic body. Capacitance characteristics are virtually flat over a wide temperature range (see graph).

Highest lead strength. Above the tensile strength of No. 22 wire itself. Leads can't pull out.

Easiest identification. Clearly labeled to avoid confusion and mistakes. Stamped with capacity, voltage rating, and tolerance.

TYPICAL ISO-KAP CURVE



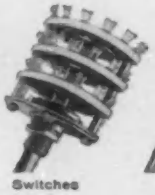
Get detailed facts that help you visualize Iso-Kap's exciting possibilities. Write for engineering bulletin EP-48.

More proof that if it's a job for electronic components, it's a job for Centralab

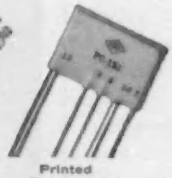
Centralab's advanced engineering continues to create the prototypes of the components industry

Volume Controls

Capacitors



Switches



Printed Electronic Circuits

Ceramics

Would you like to win a top-quality outdoor grill for cooking fun?
Enter this month's
Electroni-Kwiz†
Answer this question in 50 words, more or less: How has electronics improved our standard of living?
A leading editor will pick the winner of this month's major prize.
Mail your entry to us before May 30.

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie.

D-556

Centralab®

A DIVISION OF GLOBE-UNION INC.

918E E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

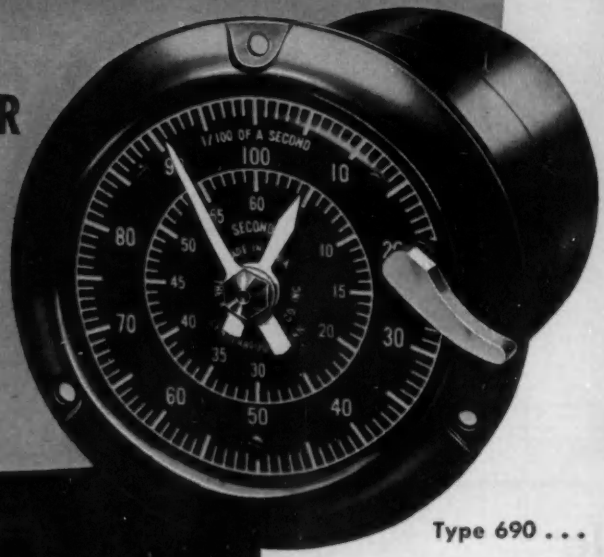
*Trademark

SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS

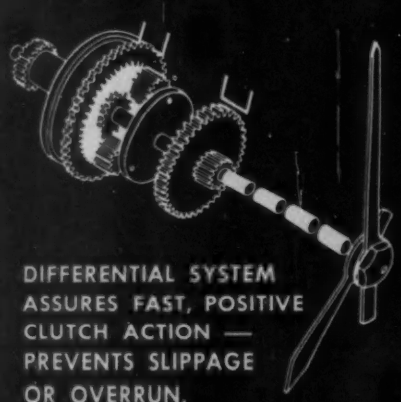
Cramer

TIME TOTALIZER

a highly accurate electrical stop clock . . .



Type 690 . . .



DIFFERENTIAL SYSTEM ASSURES FAST, POSITIVE CLUTCH ACTION — PREVENTS SLIPPAGE OR OVERRUN.

Positive engagement of pawl with gear combined with fine gear teeth provides the instant response necessary for a timing accuracy of ± .01 seconds on the 60-second timer, and ± .005 minutes on the 60-minute unit.

On the dial face, a large sweep hand makes possible fast, exact readings from the outer scale, while an accumulator pointer records larger time units on a separate scale in the center of the dial.

This compact unit is available for AC or DC operation in commercial and military applications. It is used in laboratory experimentation, for testing communications equipment and systems, and in the field of nuclear research, as well as for timing critical industrial processes.

For complete information on the Type 690, write for bulletin PB-610.

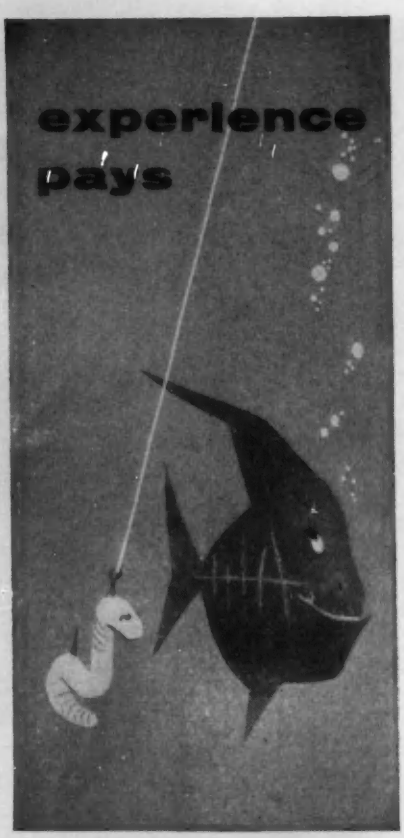
Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., *Inc.*

BOX 7, CENTERBROOK, CONNECTICUT

81CR55



Yes, experience does pay in many ways. Our clients know from experience they have a dependable, responsible source for preparation of better industrial and business literature.

Why not do the job right? It saves time, money and produces results. Let us give you a proposal on your next publication.

We'll do the whole job—from planning to printing—or just those parts that you need.

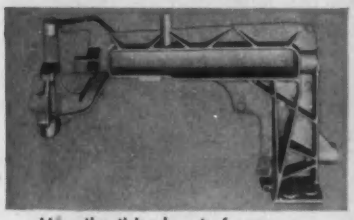
product literature
military manuals
company publications
training material

Call or write for more information.

TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc. • 330 West 42nd Street • N. Y. 36, N. Y.

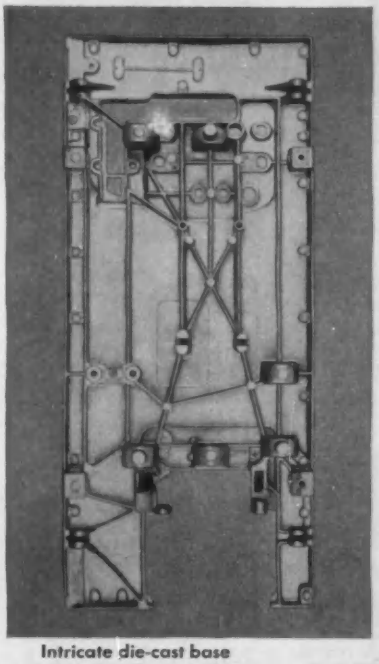
DIE CASTING REPORT

Front half, cover casting

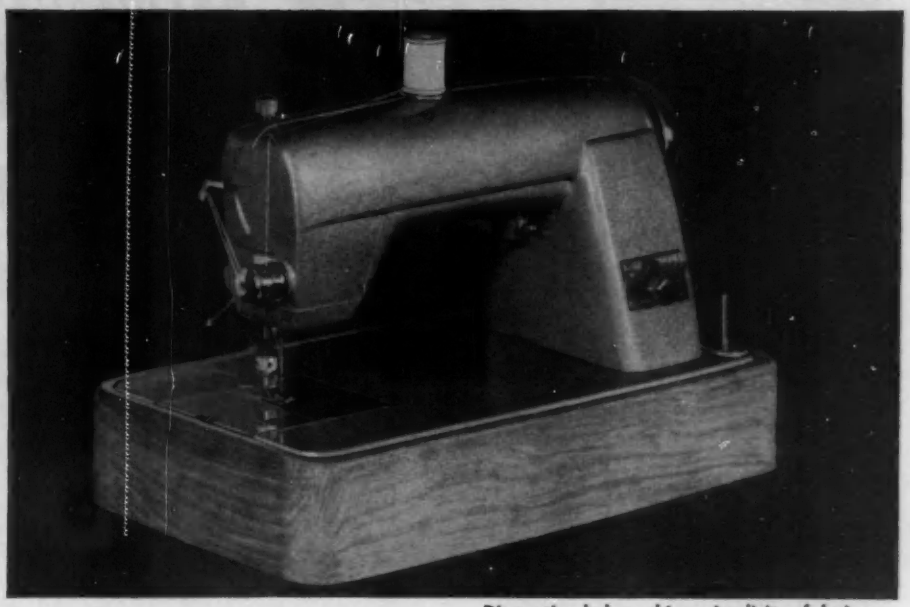


Heavily ribbed main frame

Aluminum and zinc components



Intricate die-cast base



Die-casting helps achieve simplicity of design

New Materials and Methods plus Automotive Design Thinking . . .

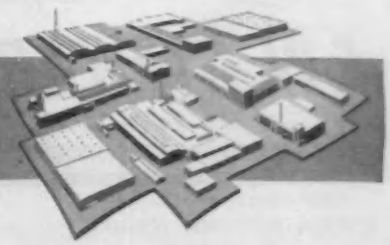
Kicked off mass production of revolutionary portable sewing machine

Automotive design thinking contributed considerably to the development of a sewing machine now being produced by the New Process Gear Corp. of Syracuse, N. Y. Faced with a customer request to build a new portable, New Process engineers discarded 50 years of standard construction methods and decided to eliminate cast iron, minimize stampings, and make maximum use of aluminum and zinc die-castings. Thinking along automotive lines they designed 4 basic die-cast parts: a front and back cover (like an automobile body), a main frame and base (the chassis). Precision engineers worked closely with customer, suggesting additional ribbing and refinements to add strength and reduce weight.

PAY-OFF:

Sewing machine has clean functional lines, weighs 50% less than competitive models. Unit has 50 less parts. Gears are eliminated. Nylon cams and a positive chain drive achieve quieter, more positive operation. Machining and assembly time and costs are held to a minimum.

Creative engineering applied to aluminum, magnesium and zinc die-cast components can help you in planning a new product or part. The Precision team of design and metallurgical engineers can show you how to reduce weight, machine and shipping costs and simplify assembly. Write for the Precision story *"Die-Castings . . . Unlimited."* Address your request to: Precision Castings Co., Inc., 241 Walnut St., Fayetteville, N. Y.

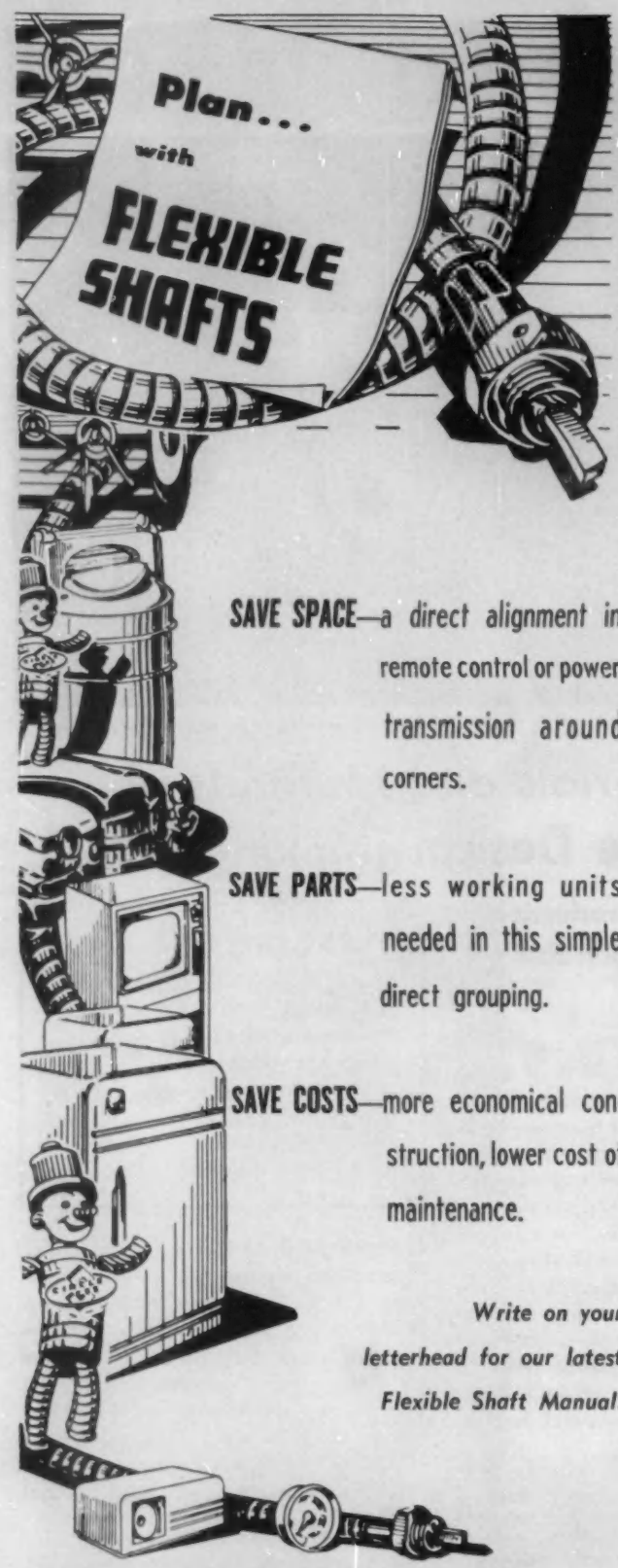


PRECISION CASTINGS CO., INC.

World's largest independent producer: aluminum, magnesium and zinc die castings

FAYETTEVILLE, N. Y. — SYRACUSE, N. Y. — CORTLAND, N. Y. — NEW YORK, N. Y.

CHICAGO, ILL. — CLEVELAND, OHIO — KALAMAZOO, MICH.



SAVE SPACE—a direct alignment in remote control or power transmission around corners.

SAVE PARTS—less working units needed in this simple direct grouping.

SAVE COSTS—more economical construction, lower cost of maintenance.

Write on your letterhead for our latest Flexible Shaft Manual.

F. W. STEWART CORP.

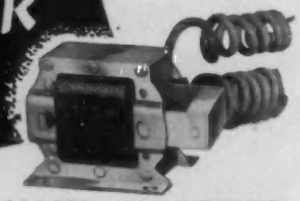
A Subsidiary of the S. S. White Dental Mfg. Co.

4311-13 RAVENSWOOD AVENUE · CHICAGO 13, ILL.

WEST COAST PLANT:
1638 So. FLOWER STREET · LOS ANGELES 15, CALIFORNIA

CIRCLE 555

DORMEYER SOLENOIDS are



ENGINEERED TO YOUR PRODUCT

Dormeyer Solenoids are built to your specifications in every detail. Constructed from only the finest materials, each unit is carefully inspected for uniform high quality.

No matter what your requirements are, we will supply them. Expanded facilities enable us to offer the widest variety of solenoid types in the industry.

DORMEYER TRANSFORMERS AND COILS

Built to the same high engineering standards as Dormeyer Solenoids. Compact, efficient—outlast equipment life. Coils to No. 50 wire.

PROMPT DELIVERY IN ANY QUANTITY

Send specifications for free estimate.
Request catalog giving full engineering data.

DORMEYER INDUSTRIES
FACTORIES IN CHICAGO AND KENTLAND, INDIANA

3414 MILWAUKEE AVENUE • CHICAGO 41, ILLINOIS

NEW FREE CATALOG

FOR
- Designers
- Purchasing Agents
- Engineers
- Superintendents
- Managers

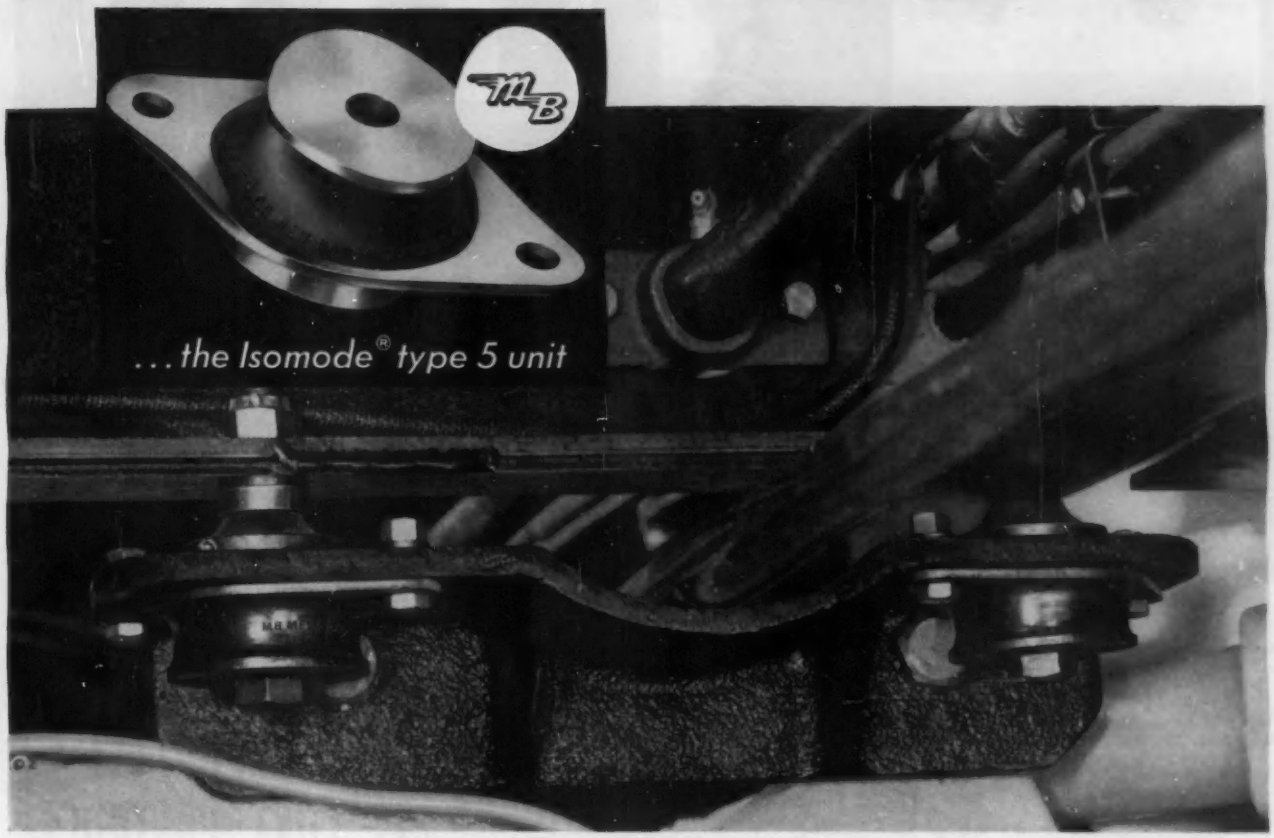
FREDDY FEDERAL
will rush your copy today!

Costs, materials, and procedures graphically illustrated. New catalog tells where and how you can save money using Short Run Stampings. Also design tips to reduce stamping costs.

Write for your copy of catalog 201 today.

Federal TOOL AND MANUFACTURING CO.
3621 ALABAMA AVE. (ST. LOUIS PARK)
MINNEAPOLIS, MINNESOTA
"QUALITY STAMPINGS IN SMALL QUANTITIES"

Standard mounts that give vibration isolation in the special class



• With Isomode Type 5 isolators, you get an unusual degree of isolation efficiency. They offer equal spring rates in all directions. This means better control of all modes of motion.

Other special advantages of Isomode Mounts: In addition to absorbing equally well troublesome vertical, horizontal and rocking motions, they can be installed at any angle, thereby simplifying design of the suspension. They offer high load capacity in compact sizes. They have plenty of rubber for vibration-absorbing softness . . . yet are stable and self snubbing against shock loads.

These features make Isomode standard mounts suitable for a wide variety of special applications. In the photo above, you see them in an underfloor bus engine suspension. You'll also find these heavy duty mounts in trucks, motor-generator sets, aircraft oil tanks, compressors . . . to name a few.

As a principal source for special-performance mounts available as standard units, MB may have the answer to *your* vibration problem. Contact us and see.

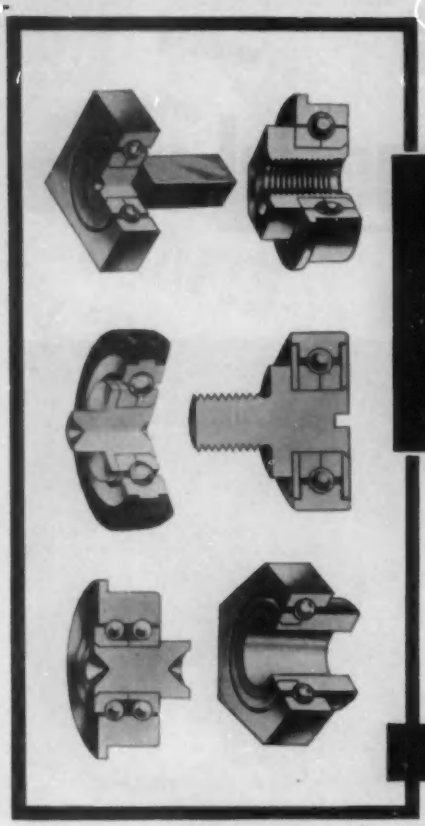
® *Reg. U. S. Pat. Off.*

BULLETIN NO. 616 gives useful and helpful data on vibration. Send for your copy of our latest revision.

the MB *manufacturing company, inc.*

1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION...TO *EXCITE* IT...TO *MEASURE* IT



UNGROUND BALL BEARINGS

For All Industries

KILIAN

Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

Distributors in All Principal Cities ***Catalog on Request***

KILIAN MANUFACTURING CORP.

SYRACUSE, NEW YORK, U. S. A.

ASSOCIATED COMPANIES:
Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

Save Draftsmen's Time

YOUR OFFICE TYPIST CAN DO THE LETTERING JOB

Why waste a good draftsman's time on hand lettering. Your typist can do a neater and more legible job...4 times faster...on the Vari-Typer lettering machine. Easy to operate. Universal keyboard with hundreds of instantly changeable type styles.

For any method of duplicating or reproduction

Handles tracings 12 ft. or more in width

Vari-Typer®

LETTERING MACHINE

RALPH C. COXHEAD CORPORATION
720 Frelinghuysen Avenue, Newark 5, N.J.
Please send VARI-TYPER Booklet E-31
NAME.....
COMPANY.....
ADDRESS.....
CITY.....ZONE...STATE.....

HOW IMPORTANT IS COST CONTROL?

Some research engineers believe that the work of "costing" research problems is valuable time lost from more creative tasks. Experience shows, however, that well-planned systems of cost control can give research teams both a better understanding of design problems, and better methods for attacking these problems.

A detailed discussion, complete with charts and tables, of how you can organize such a program can be found under the General Engineering classification of your 1955 Annual HANDBOOK of Product Design. Hundreds of other informative and provocative articles also are contained in this issue (and in your '54 and '53 HANDBOOKS).

Product Engineering
McGraw-Hill Building,
New York 36, N. Y.

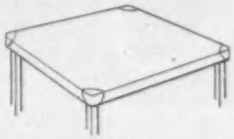
TAYLOR Laminated Plastics Vulcanized Fibre Shop Talk

TAYLOR FIBRE CO.

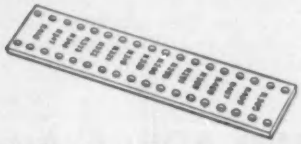
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

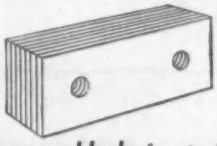
Tips for designers



Furniture can make good use of the mar-resistant, tough surface afforded by Taylor Vulcanized Fibre plywood combination table tops.



Terminal strips for high-precision electronic instruments benefit by the excellent insulating properties of Taylor XXXP-301 hot-punch phenol laminate.

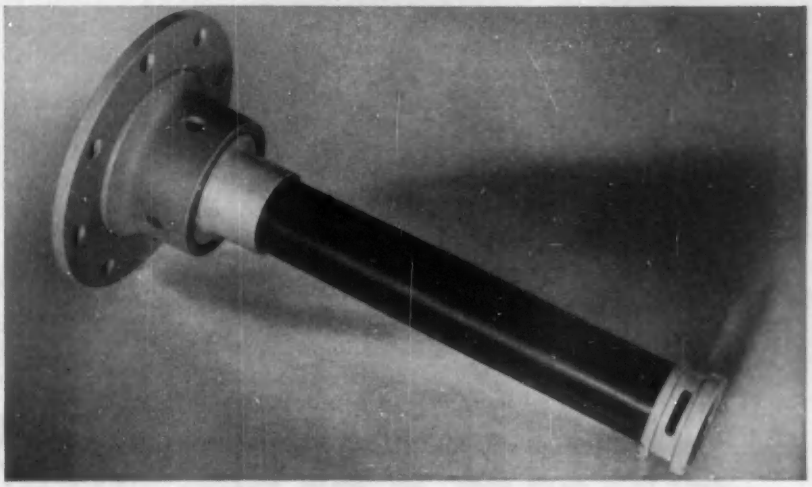


Heavy bumper blocks for steel mill use, made of Taylor Built-Up Fibre several inches thick, give long service under severe shock and abrasion.

Selenium rectifier plates are insulated by washers made of Taylor Grade 353 phenol laminate . . . chosen for its dimensional stability and mechanical strength.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.



High strength, light weight, excellent insulating and corrosion-resistant qualities make Taylor Epoxy Glass Base Laminate the ideal material for tubing in an aircraft fuel gage tank unit made by Avien, Inc.

When service conditions are tough— *use Taylor special-purpose laminates*

Designing for severe service? Then take a look at what Taylor special-purpose laminates can do. Taylor's resin chemists have developed special formulations of melamine, silicone and epoxy resins . . . for combination with a variety of base materials. The result is a line of laminates which offer the plus performance that your new designs may require.

Taylor epoxy laminates. Retain superior mechanical properties after exposure to high temperatures (above 430 F) . . . have outstanding electrical characteristics, moisture resistance and resistance to corrosive chemicals . . . setting these laminates apart as a means of solving difficult design problems.

Taylor melamine laminates. Excellent resistance to arcing, electrical corona, flame and chemical attack characterizes these materials . . . useful in many electrical applications.

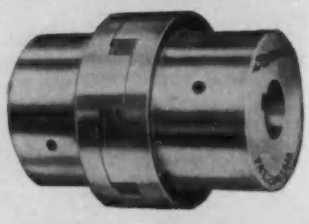
Taylor silicone laminates. These withstand temperatures up to 500 F . . . provide insulation where other laminates thus far cannot be used. They also possess high mechanical strength, low power factor and low moisture absorption.

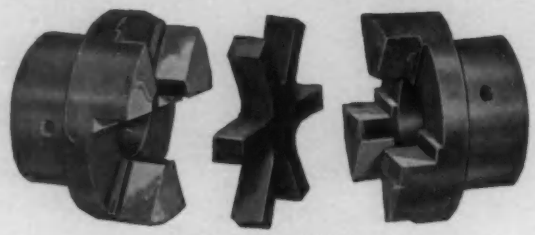
Sheets, tubes and rods of these materials are available in a range of sizes that will give you maximum economy of material in your manufacturing processes.

To help you in the application of these specialized materials to your specific product, Taylor offers the service of its experienced engineering staff. Call on Taylor for a consultation on your individual requirements.

Specify the Coupling that lives a DOUBLE LIFE...

The BONDTRU Coupling has double life. When the coupling is operating in one direction only, every second arm of the insert carries a load, while the remaining arms serve to prevent backlash. Should the load carrying arms become worn through long use, the insert can be moved up one position, putting in place the other set of arms which have remained unimpaired.





Patent No. 2,003,848
Canadian Patent No. 295,340

BONDTRU

Flexible

INSULATED COUPLING

The BONDTRU Coupling can be adapted with complete satisfaction to practically any application where a flexible connecting medium is required to transmit from ¼-h.p. up to 100 h.p. at 100 r.p.m.

EASY ON BEARINGS—The self-aligning feature of the BONDTRU Coupling minimizes wear on the bearings by compensating for both lateral and angular misalignment of the driving and driven shafts.

NO MAINTENANCE NEEDED—Another advantage of the BONDTRU is that it has no moving parts—nothing that needs lubrication.

For complete information on Bond Flexible Insulated Couplings, write for Catalog No. F-24.

Carried in stock by
DISTRIBUTORS IN PRINCIPAL CITIES
Consult your local Classified Directory or write to

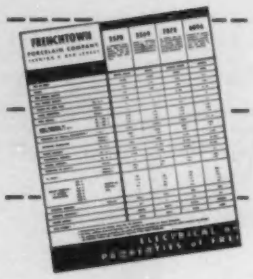
CHARLES BOND COMPANY
617-23 Arch Street, Philadelphia 6, Pa.

Bond®
STOCK GEARS
SPEED REDUCERS

engineered ceramics?

IF YOU ARE LOOKING for a supply source capable of providing high-performance materials that give you resistance to high temperatures and low thermal expansion; excellent mechanical strength and wear resistance; superior dielectric strength and both high and low frequencies—

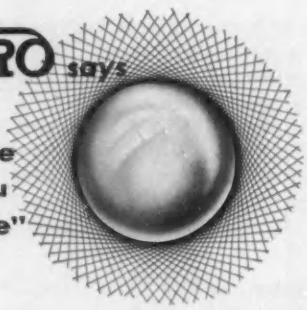
A GOOD SOLUTION to your problem is to check with Frenchtown. Asone of America's leaders in engineered ceramics for over 40 years, we are in a position to serve you in three ways: (1) providing research facilities for product improvement through *engineered* ceramics, (2) assisting in design and development work, (3) producing required parts and components in any quantity, to your most exacting specifications. Want to know more? Write for literature.



frenchtown PORCELAIN COMPANY
87 Muirhead Avenue • Trenton 9, New Jersey

FOXBORO says
REG. U. S. PAT. OFF.

"a new seating surface every time you close the valve"



In its new Universal Valve, Foxboro insures long life, tight seating, positive shut-off, with a unique ball-seat construction utilizing a ¼" hardened stainless steel Hartford Ball. Every closing brings a new surface into contact with the valve seat because the ball, retained in a housing at the end of the stem, is free-rolling.

Just another one of a thousand uses for Hartford Precision Balls.

Hartford
STEEL BALL CO., INC.
Hartford 6, Connecticut

5H655

Solar is building these convoluted couplings for a nuclear process installation.

All of Solar's U-span bellows are made to conform with API and ASME codes.

Solar makes both!

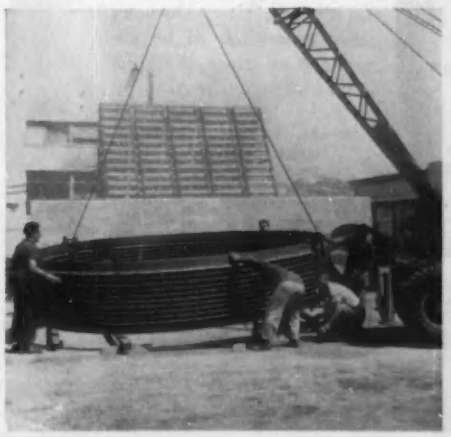
Convoluted and U-span expansion joints to meet any requirement

YOU'RE SURE TO GET the right type of expansion joint from Solar. Sola-Flex U-span joints are designed for heavy industrial use, where extreme ruggedness is needed. In low pressure applications where lighter construction is often preferred Sola-Flex convoluted bellows are available in a variety of sizes.

This versatility — plus Solar's high standards of engineering and manufacture — means that you can depend on Solar for joints that are durable, economical, and custom-designed to fit your need.

Both standard expansion joints, and special designs, are described in Sola-Flex catalogues. For unusual applications, experienced Solar engineering teams are available for advice. Bring your problems of pressure and temperature to Solar — you're sure to get the right solution!

Solar has built the world's largest expansion joints for a government-sponsored research project.



SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS OF METAL ALLOY PRODUCTS

This is What Solar Offers You

When heat, corrosion or difficult specifications are problems, Solar can help you solve them. Solar specializes in the manufacture of precision products from alloys and special metals for severe service. Solar's experience since 1927 is unduplicated in this field.

SPECIAL PRODUCTS

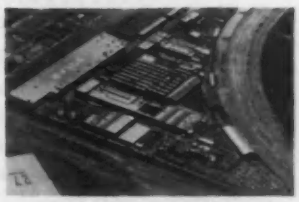
Gas Turbines. *Solar "Mars" 30 hp engines for auxiliary generator sets, ground carts, portable fire pumps; Solar "Jupiter" 500 hp engines in variable and constant speed models.*

Bellows. *"Sola-Flex"® bellows and expansion joints in many designs from ½ in up to the world's largest, 28 ft in diameter.*

Controls. *Complete control systems utilizing the new Solar "Microjet"® principle for control of gas turbines, jet engines and pneumatic devices.*

CONTRACT PRODUCTION

Current orders include aircraft engine and airframe parts, pneumatic ducting, atomic energy components. Customers include the finest aircraft and industrial companies in the U.S. and Europe.



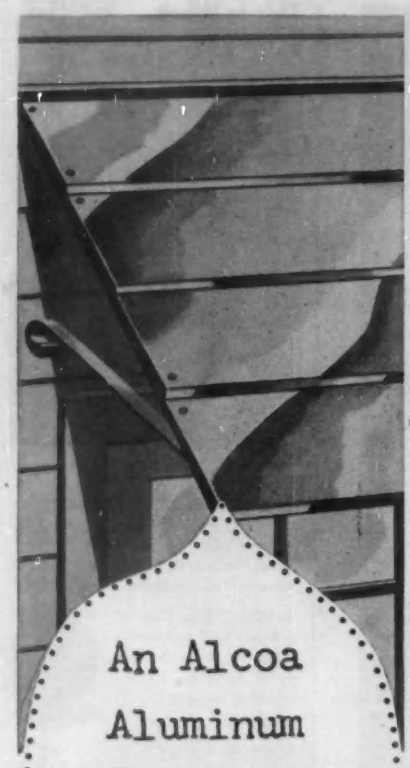
Plants. *In San Diego (photograph above) and Des Moines. A total of 1,400,000 sq ft of floor space. Approximately 5,000 employees. Annual sales over $65,000,000.*

Services. *Research, design, development and production engineering staffs. Experienced with all alloy steels, stainless alloys, super alloys, and titanium and its alloys.*

Facilities . . . *for all types of metal fabrication—forming, machining, welding, brazing, casting, coating. Equipped for prototype, limited or mass production. Extensive laboratories. Complete quality control.*

INFORMATION

For more information regarding any Solar product or service listed above, write Solar Aircraft Company Department B-16 San Diego 12, California



An Alcoa Aluminum Fastener should be used here!

It's an aluminum awning assembly, worth the lasting strength of Alcoa® Aluminum Fasteners. You avoid galvanic and atmospheric corrosion. You get perfect color match; you get the very highest quality product. Your local Alcoa distributor has a complete stock.

P. S. In this awning assembly, we suggest an aluminum sheet metal screw from Alcoa's complete line of aluminum fasteners.

Aluminum Company of America
2247-E Alcoa Building, Pittsburgh 19, Pa.
Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.

name _____
title _____
company _____
address _____

Always Fasten Aluminum with Alcoa Aluminum Fasteners

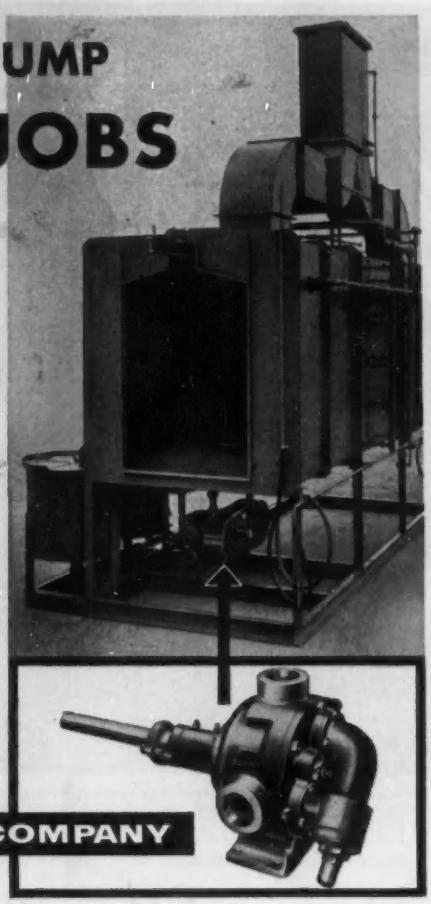
ONE VIKING PUMP DOES 3 JOBS

on Erikson Flow Coating Paint Booth

Viking pumps used on the flow coat machines built by Erikson Mfg. Co. of El Monte, California serve a multi-purpose. Due to the reversing feature of Vikings, a single pump is used to supply paint to the machine and, when reversed, is a fast cleaning pump.

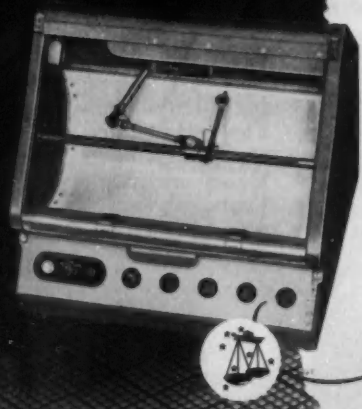
Another outstanding feature of this Viking pump is the variable speed and capacity change. This readily permits regulating rate of flow for painting different size parts.

Whatever your pumping problem for handling thick or thin liquids, ask Viking for the answer. Start today. Ask for folder 55Sx.



VIKING PUMP COMPANY
Cedar Falls, Iowa
See our catalog in SWEETS

X-Y PLOTTER AND RECORDER



RECORDS TWO INDEPENDENT VARIABLES FROM ANALOG OR DIGITAL INPUTS

A compact, desk-size unit designed for general purpose graphic recording from analog or digital inputs with standard Librascope converters or special modifications engineered to customer requirements. Unique pen travel, fast and dependable. Full chart visibility allowing curve generation to be observed at all times. *Write for detailed catalog information.*

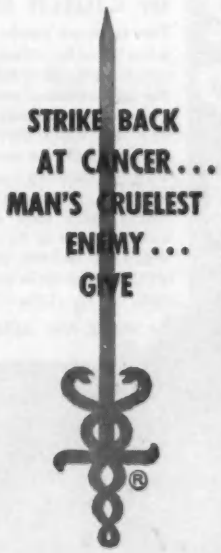
Mechanical and electrical analog computers, digital computers, input-output devices and components.

Computers and Controls

LIBRASCOPE

LIBRASCOPE, INCORPORATED
1607 FLOWER ST., GLENDALE, CALIF.

HELP SAVE ONE FRIEND FROM CANCER



Tens of thousands with cancer will lose their lives needlessly this year. They could have been cured by early diagnosis and prompt treatment.

Will one of these unfortunate victims be a friend of yours? It could happen. We know that cancer strikes one in four.

There's a way to help that friend, and thousands of others. That's by helping the American Cancer Society spread its educational message as widely as possible.

Money you contribute improves services to patients, arms everyone with protective information about cancer, and pays for research to conquer this cruelest of diseases.

When you give your dollars to the American Cancer Society, you are making an investment that pays off in the saving of human lives. Perhaps the life of one friend.

Perhaps your own life.

American Cancer Society

GENTLEMEN:

I want to help conquer Cancer.

( ) Please send me free information about Cancer.

( ) Enclosed is my contribution of $____ to the Cancer Crusade.

Name_____

Address_____

City_____ Zone____ State_____

(MAIL TO: CANCER, c/o your town's Postmaster)

BRISTOL SCREWS SHOWN are 2½ times actual size.

Miniature Socket Screws Down to No. 0 for Every Application

These Tiny Socket Screws are Standard with Bristol in sizes from No. 0 and up in Bristol's Hex and Multiple-Spline Socket Set and Cap Screws – in alloy and stainless steel.

We have been specializing in small-size socket screws for many years and have been making them by the millions in sizes down to No. 0 since 1950.

Gear-like teeth in Bristol's Multiple-Spline Socket enable the wrench to actually *pull* the screw around. *All* wrenching force is transmitted into rotary power. As a result these tiny screws can be wrenched tighter . . . to hold tighter.

Designed to fit right in with today's automation techniques, millions of Bristol's Multiple-Spline Socket Screws are used every year by leading makers of computers, instruments, guided missiles, razors, cameras and other precision products.

Ask your industrial distributor for Bristol's Multiple-Spline Socket Screws today. He's got them in sizes down to No. 0 wire. A.5.4

Standard in sizes as small as No. 0 in Alloy Steel and Stainless Steel.

BRISTOL'S SOCKET SCREWS

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

Light metals design tips

Ease of machining magnesium is important product design factor

Of all structural metals, magnesium is easiest to machine. Magnesium normally requires only one-half the power necessary to cut aluminum or brass, one-third the power needed to cut cast iron, one-sixth the power required to cut mild steel and one-tenth the power to cut nickel. Due to the superior machinability of magnesium, an excellent surface finish can be achieved at minimum cost.

All machines suitable for cutting other metals can be used with the various magnesium alloys. Woodworking tools, as shown in photo above, can be used in some instances. Tool cutting edges should be kept sharp, and heavy cuts at high speeds are recommended.

Whatever your light metals problem . . . count on Magcoa engineering counsel and fabrication facilities.

MAGNESIUM COMPANY OF AMERICA
LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.

FAST POWER PICK-UP OR STOPS!

Miniature, precision CLUTCH or Clutch Brake

These components provide instantaneous response for use in electro-mechanical control systems, servo-mechanisms, computers, missile instrumentation, and other devices.

Energizing the coil magnetically engages input and output shafts. De-energizing disengages shafts, and provides brake action if desired. Energizing or de-energizing will induce no angular displacement error. Through output shafts allow concentric input and output on the same end for use in gear train mounting. Standard coil voltage is 28v dc, but can be modified to requirements. Dia. 1¼". Lgth. 1¾". Wgt. 6.6 ozs.

WRITE FOR DETAILS TODAY!

GLOBE INDUSTRIES, INC.

Motors • Gear Reducers • Fans
Generators • Governors
Servos • Blowers • Actuators
Switches • Gyros • Vibrators

1798 STANLEY AVE.
DAYTON 4, OHIO

Never a Better Reason for Switching to Copyflex . . .

NEW COPYFLEX MODEL 500

Here it is! The faster, easier-to-use, heavy-volume Copyflex reproduction machine that sells for the low price of $3,250.00 f.o.b. Chicago. It's your best reason ever for joining the switch to Copyflex!

NEW! Larger front tray takes prints up to 24" x 32". Larger rear tray takes sizes up to 30" x 42". Extra-roomy tracing tray handles originals up to 12". Special tracing stacker, variable front print stacker, and print roll-up attachment are available at extra cost.

NEW! Model 500 gives fast, 40 f.p.m. speed. Its 4,000-watt quartz lamp and synchronized exposure and developer units assure clear, high contrast prints.

NEW! Patented air-jet separator provides reliable automatic separation of tracings from exposed sheets.

NEW! The electrical control system is free from vacuum tubes, a common source of trouble in most other reproduction machines. It uses such devices as 100,000-hour-life rated selenium rectifiers and variable transformers to assure efficient, trouble-free operation.

PLUS Model 500 is free from fumes, requires no venting or plumbing. It offers such Copyflex extras as exclusive vacuum feed, adjustable light shield, and special feed release treadle.

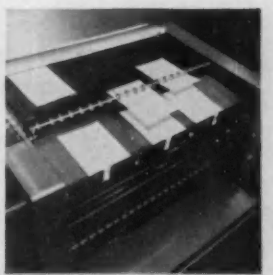
Never has any reproduction machine offered so much. Never have you had a better reason for trading in that old machine and joining the switch to Copyflex. Mail coupon today.

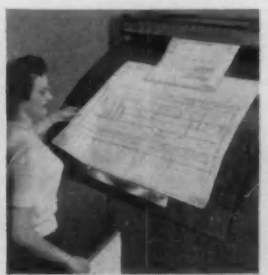
ANY WAY YOU LOOK AT IT, THE NEW MODEL 500 IS YOUR BEST BUY TODAY!

BRUNING Copyflex

Best Process! Best Machines! Best Selection of Materials!

Model 500 provides fast 40 f.p.m. speed and 46-inch printing width for heavy-volume reproduction. New type indicator shows actual speed.



Variable front print stacker (optional) can be set quickly by control knob to provide positive stacking for prints from 6" to 24".

Larger rear delivery tray handles up to 30" x 42" prints. Movable magnetic stops provide variable stacking.

Charles Bruning Company, Inc., Dept. 1614. 4700 Montrose Ave., Chicago 41, Ill.

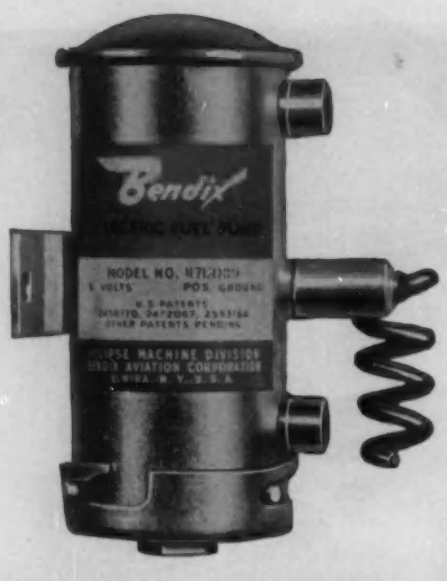
Please send me information on the new Copyflex Model 500.

Name_____ **Title**_____

Company_____

Address_____

City_____ **County**_____ **State**_____



TWELVE REASONS WHY...

Bendix Electric Fuel Pump performs better ... lasts longer!*

- **Performance-proven**
- **Longer Life • No Pressure "Droop"**
- **Dependable Operation at −75°F.**
- **Improves Low Temperature Starting**
- **Built-in Pressure Release**
- **Eliminates Vapor Lock**
- **Delivers More Gallons per Hour**
- **Easy to Install • Easy to Service**
- **Low Power Requirements**
- **Economical Operation**
- **Light Weight • Compact**
- **Rugged • Tamper-proof**

Learn more about this new and improved fuel pump. Write for descriptive folder and specifications.

*REG. U.S. PAT. OFF.

ECLIPSE MACHINE DIVISION
ELMIRA, N. Y.

THE NAME Bendix AVIATION CORPORATION MEANS MORE

Bendix* Electric Fuel Pump
Bendix* Folo-Thru Starter Drive
Stromberg* Aeroquad Carburetor

ROTATING or STATIONARY ASSEMBLIES held together EASIER with

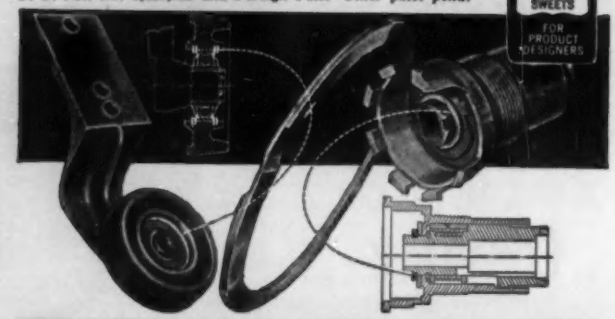
SpirOlox Retaining Rings

Conveyor roller application at left shows how Spirolox attains neat, compact, simplified design, even on rotating assemblies. Stationary application of lock assembly illustrates how Spirolox can be applied to hard-to-reach places where retaining ring must operate in very confined space. Secret of Spirolox adaptability is patented *two-turn* construction, which makes possible unique locking characteristic... will not jump out of groove. Always provides a uniform shoulder... no lugs, no gap.

FREE DATA BULLETIN. Send blueprint of your retaining problem. Ramsey Corp., St. Louis 8, Mo.

U. S. Pat. No. 2,450,425 and Foreign Pats. Other pats. pend.

SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS



Rotating or Stationary

SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

LET US HELP YOU

Design

A BETTER NAME PLATE

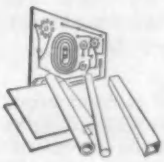
Mark your product for more sales with stand-out identification. Our long experience, skilled craftsmanship, and latest equipment enable us to create name plates that reflect the quality of your product. Without obligation to you, our artists will help you design a name plate that you will be proud to use as the "signature" on your product.

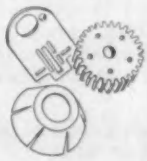
Chicago Thrift-Etching Corporation
CHICAGO, ILLINOIS

Send a Rough Sketch, blueprint or sample with specifications, for design suggestion and quotation, without obligation. Ask for Free Book containing full color examples.

CHICAGO THRIFT-ETCHING CORPORATION
1555 N. SHEFFIELD AVE., CHICAGO 22, ILL., DEPT. B.
SUBSIDIARY OF DODGE MANUFACTURING CORPORATION, MISHAWAKA, INDIANA

"Get prices down! Keep quality up! *BUT HOW?*"





With the many materials now available, and new ones coming on the scene, how can a designer be sure he's got the right answer?

Here's one way. Work with a company that has an exceptionally broad line of basic engineering materials, plus the research facilities and production experience you need to support your decision.

NVF materials—Vulcanized Fibre, Phenolite Laminated Plastic, Metal-Clad Phenolite and Fibre, Peerless Insulation—are surprisingly adaptable. Each is manufactured in many forms, grades, and combinations, with various degrees of hardness, resilience, flexibility, insulating ability, dielectric strength, moisture resistance, and ease of fabrication. What they can do—to reduce costs and preserve product quality—has raised many a manufacturer's eyebrows *and profits!*

NVF design assistance is complete. Our technical people can work with you while your project is in the head-scratching stage—make sure that you get exactly the right material or product for the specific job. But even more important, they stick with the project until it's completed to your satisfaction.

NVF maintains complete facilities for machining and forming ready-to-use parts. This saves you operating steps and gives you 100% usable parts. Working with a single integrated supplier often turns red figures into black ones.

If you have a design problem, call on National. It's the job of our engineering staff to discover ways and means of applying NVF materials to your difficult applications. Full details of our materials and services are yours without obligation.

Write for sixteen-page General Catalog, attention Dept. B-5.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada: **National Fibre Company of Canada, Ltd.** • Toronto 3, Ont.

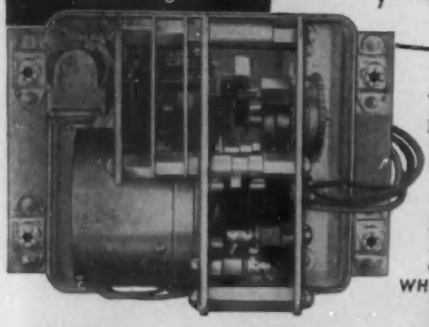
Also Manufacturers of Peerless Insulation, Materials Handling Receptacles, Vul-Cot Wastebaskets and Textile Bobbins.

There'd be no "blip" without power control by the

A.W. HAYDON COMPANY

*Blip — Reflected Radar Signal

DESIGNED for AIRBORNE RADAR...



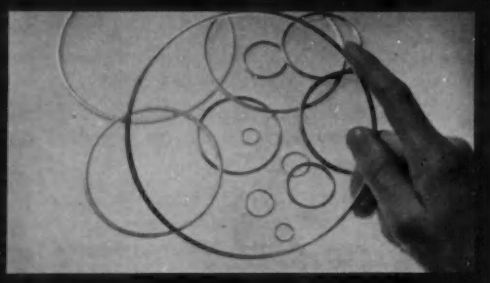
This Time Delay Relay is used to delay application of plate power to vacuum tubes until filaments reach operating temperature. It provides maximum reset rate with minimum "time-out". — Eliminates danger of costly tube damage. — Provides *faster* response. Send for information about this Time Delay Relay and other special cost-saving timing devices.

WHEN TIMING POSES A PROBLEM CONSULT

double delayed reset time delay relay

The A.W. HAYDON COMPANY
221 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

CYLINDER HEADS
HYDRAULIC PRESSURES
HIGH OCTANE FUELS
AIR PRESSURES
VACUUM CONNECTIONS
VAPORS AND GASES
OILS AND SOLVENTS
STEAM CONNECTIONS
CHEMICALS AND ACIDS



Sealed with... metallic O-rings

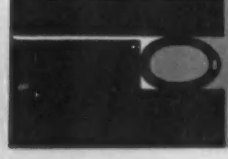
Self Energizing Feature

. . . as applied to Metallic O-Rings is United's answer to the positive, permanent control of high pressures with a metal-to-metal static seal. Drilling holes through the I.D. wall of the O-Ring creates a unique method of venting the tube of the ring to allow the sealed pressures to enter the ring. A balance of pressure then exists within the O-Rings to prevent its collapse. An unbalance of pressure forces exists across the sealing surfaces to increase the resilience of the O-Ring.

22 pages of engineering data—write for your copy today (on your company letterhead please) to Department F]

METALS

1. Steel-SAE 1020 (Not Recommended for Self-Energizing) (Special)
2. Stainless Steel — Type 321 (Standard)
3. Al. Alloy 35 (Spec. WW-T-788) (Special)
4. Copper — Pure (Spec. WW-T-797) (Special)
5. Inconel (Special)



UNITED AIRCRAFT PRODUCTS, INC.
Box 1035, Dayton 1, Ohio

Want Help with Your Design Problem?

Hundreds of America's consulting design engineering firms are prepared to give you assistance when your own facilities are overcrowded . . . they're organized to complete projects quickly when speed in development is essential . . . and they often can give you a fresh viewpoint on product design.

These are just a few reasons why you may find it profitable to call in one or more of these consulting firms. And whether you may need the assistance of a consulting firm now or in the future, we can help you locate the firm or firms best able to service your needs. We recently completed a study of the consulting engineers that subscribe to *Product Engineering*. The information compiled has been indexed and filed by our Research Department, and is available to you.

The files, for example, contain data on firms which do up to $5-million in business annually . . . employ from one to as many as 500 engineers and technicians . . . and which, in most cases, can design any kind of machinery and equipment. These companies also specified the one or more areas of design—mechanical, hydraulic and pneumatic, electronic and electrical, appearance, and other types—in which they work.

Almost all of these organizations indicated that their services are complete to the extent of specifying materials and components, preparing bills of material and work drawings for the products they design. They also stated the geographical areas in which their services are available. And many companies, in addition to replying to our questionnaire, furnished bulletins and brochures covering their activities, photographs of products designed, and lists of clients served and patents awarded.

To take advantage of this wealth of data, call or write our Research Department. There's no cost or obligation, of course.

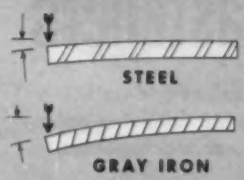
Product Engineering

McGraw-Hill Building, New York 36, N. Y.

FACTS THAT FIGURE in lower costs

FACT:
Steel is two to three times as strong as gray iron.

FACT:
Steel is two and one half times as rigid as gray iron.



FACT:
Steel costs only a third as much as gray iron.

AND SO... *by manufacturing your products from welded steel, costs can be reduced up to 50%.*

How this locomotive manufacturer proved that

WELDED DESIGNS WEIGH LESS—COST LESS

WEIGHT CUT 25%

Weight of a cast steel generator armature spider was cut 25% by redesigning for welded fabrication. With welded design, sections made of mild-steel plate are thinner with ample strength to meet all requirements. Balancing is simplified by uniform distribution of metal.

COST IS LESS

Because the weldment is produced much closer to the finished size, machining costs are reduced. Lighter weight of the spider results in a substantial savings in material costs. Concentricity of the weldment surfaces lead to longer tool life.

How you can cut costs...NOW

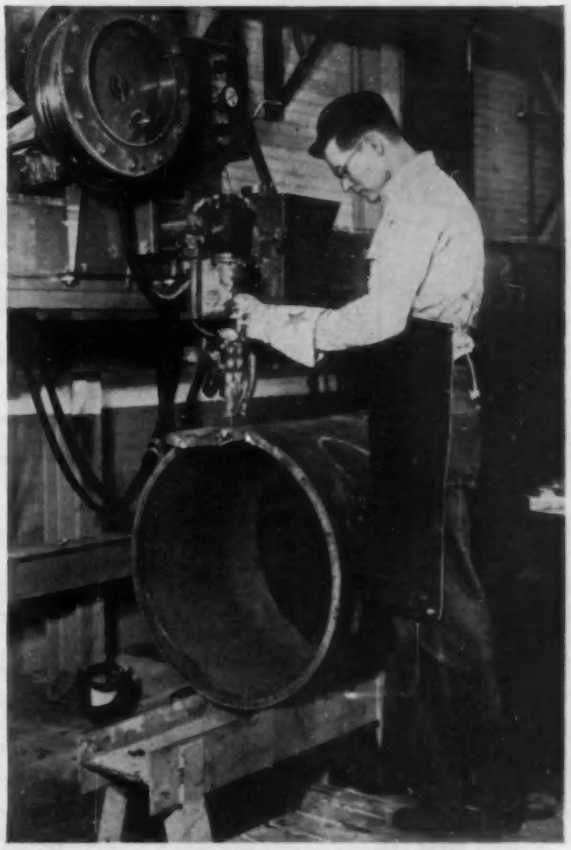
Because steel is stronger, more rigid than iron, yet costs a third as much per pound, costs on many products can be cut as much as 50%.

You can realize such savings on your designs, on products you manufacture, without disrupting production. Simply change over your designs one part at a time.

A Lincoln representative will gladly work with you to simplify designs and cut costly production manhours.

WELDESIGN MANUAL

shows how to convert designs to welded steel with minimum design time. Available to product engineers and designers at nominal cost. Write today.



Longitudinal butt welds are made on armature spiders with Lincolnweld using mild steel L-60 wire of 5/32" diameter and Number 780 agglomerated flux. Two passes fill the V-groove produced by scarfing the ends of the plate where they are joined.

THE LINCOLN ELECTRIC COMPANY

Dept. 1303 • Cleveland 17, Ohio

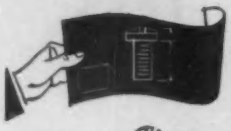
The World's Largest Manufacturer of Arc Welding Equipment

Tips on Cutting Costs in Ordering Fasteners

You can avoid unnecessary delays and costly misunderstandings by checking the following points when inquiring about or ordering fasteners.

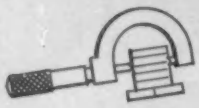
DO

Specify all allowable tolerances —indicate whether all PLUS, all MINUS, or PLUS and MINUS.

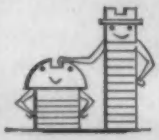


Submit sketch if possible (may be rough as long as dimensions are clearly shown).

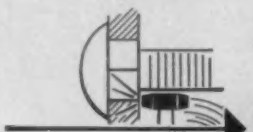
Submit samples if possible.



Specify as liberal tolerances as intended use will permit. (Close tolerances increase costs.)



If any special allowance is to be made for subsequent plating the thickness of plate should be specified.



Where square shoulders are to be subsequently staked over, this fact should be so stated.

DON'T

Don't specify dimensions in decimals when fractional dimensions are sufficient.

Don't specify lengths in units finer than necessary.

REPRINTS *of this chart are available on request for use in drafting and purchasing departments.*

QUALITY PROMCO BRAND

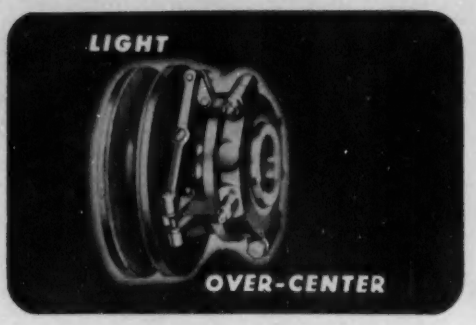
MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY

48 NORWOOD ST., TORRINGTON, CONN.

ROCKFORD



FOR USE WITH PULLEY SPROCKET OR DRIVING CUP

COMPACT DESIGN
POWERFUL PULL
SMOOTH ENGAGEMENT
UNIFORM PRESSURE
FINE ADJUSTMENT
ACCURATE BALANCE
LONG SERVICE LIFE

*This small diameter, heavy duty ROCKFORD Toggle-type, Over-Center CLUTCH fits readily into product designs. Is well suited for use with gasoline engines or motors, in applications within its torque rating.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

BW

ROCKFORD CLUTCH DIVISION BORG-WARNER
▲ 209 Catherine Street, Rockford, Illinois, U.S.A. ▲

CLUTCHES

You Don't Need a Drafting Room...

with UNIVERSAL'S new

DESK-TOPPER

Everything right at your finger tips, ready for action! One handy carton contains new low-cost professional drafting machine, folding drawing board, scales and accessory boxes. Takes just two minutes to set up! Have a free demonstration in your own office! Write direct or contact your nearest drafting materials dealer.

FIRST SINCE 1901

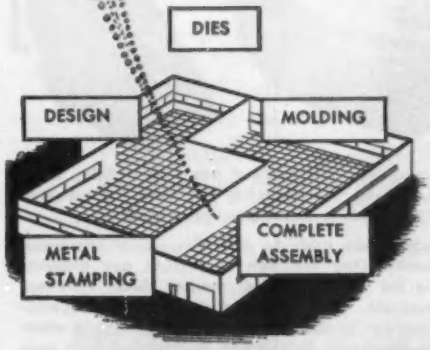
UNIVERSAL DRAFTING MACHINE CORPORATION

7960 LORAIN AVE. • CLEVELAND 2, OHIO

custom-molded

Plastic Parts

—Sylvania's model facilities offer complete "one source" service



ONE production schedule . . . one delivery cycle—one responsibility! These are the conveniences you get with "one source" supply of plastic parts custom-molded for your product by Sylvania.

These are the Sylvania services which make it all possible: expert die making . . . automatic molding in thermoplastic and thermosetting materials . . . metal stamping and forming . . . complete assembly.

Whatever the nature of your products, Sylvania invites you to apply its model custom molding facilities to your own needs. Write or phone. We will be happy to have a representative meet with you and discuss your problems.

Write Department E-33S.

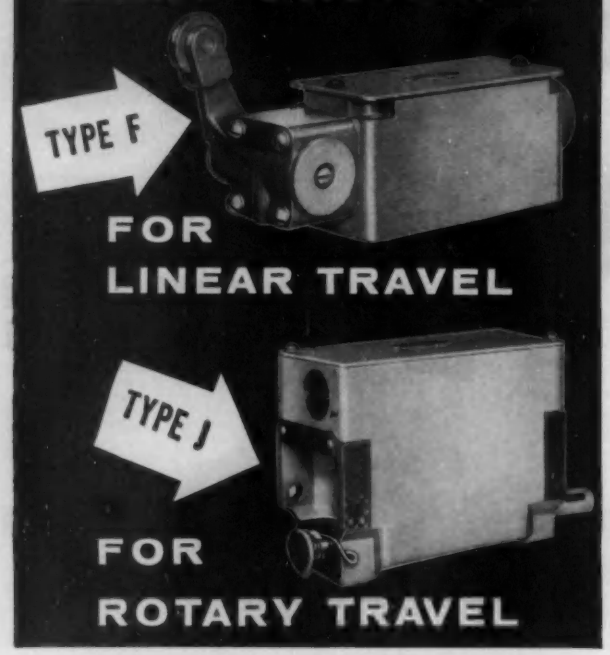
SYLVANIA

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine St.
Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

CUTLER-HAMMER BULLETIN 10316

LIMIT SWITCHES



Both Cutler-Hammer Limit Switches shown above are widely preferred because of their tremendous range of adjustment, flexibility of application, and dependability of operation.

THE BULLETIN 10316 TYPE F

linear travel limit switch is used on many different types of machines, machine tools, cranes and hoists, to reverse motors, to initiate automatic cycles. Operating heads mount in any one of 4 quadrants, making it easy to position switch. Roller lever, push roller or push rod operating heads. Roller lever sets in 90 positions 4 degrees apart. Trip in both directions, or trip in one and by-pass in other direction. Two circuits, one normally open, one normally closed. Contacts adjustable for different overlaps or no overlap. Twin-break, quick make and break, silver-to-silver contacts. Durable, rugged construction. All standard enclosures. Maximum ease of wiring and accessibility.

THE BULLETIN 10316 TYPE J

rotary travel limit switch used on reciprocating equipment, machine tools, motor-operated doors and windows, baling presses, hoists, etc., to limit the number of shaft rotations. Adjustable in increments of 1/20th of a turn, between ½ turn and 100 turns. Resets on ½th turn in reverse direction. Adjustment knob outside case. Available in 2 circuits with normally closed contacts easily changeable to normally open contacts. In 4 circuits with normally open or normally closed easily changeable to 2 normally open, 2 normally closed. Both sizes are available in NEMA 4 watertight and NEMA 5 dusttight construction. Write for further details now.

CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Secure Fastening without Threading Notching, Cotter Pins, etc.

TYPE C
(Closed End)

PUSHNUTS
Trademark

TYPE K
(Open End)

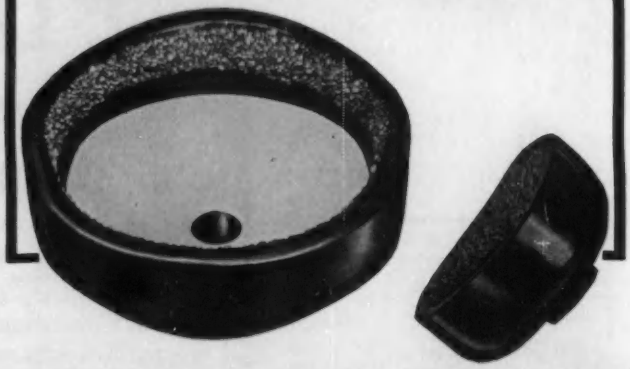
NINE POINT GRIP
of heat-treated spring steel resists removal. Design assures straight positioning.

For unthreaded rod--axles--rivets

Place PUSHNUT on end of rod, tap with hammer, it's locked. Low in price—easy fast assembly—reduces cost of other parts—provides decorative appearance. Made of heat-treated spring steel for strong holding power. Used on wheeled vehicles, playthings, chairs, ironing boards, spring-loaded devices, etc. Where can you use PUSHNUTS? Sizes for 3/32", 1/8", 1/4" and 5/16" rod, in various finishes. Send for free samples and Bulletin 568.

The PALNUT Company
65 Cordier St., Irvington 11, N. J.
In Canada:
P. L. Robertson Mfg. Co., Ltd., Milton, Ont.

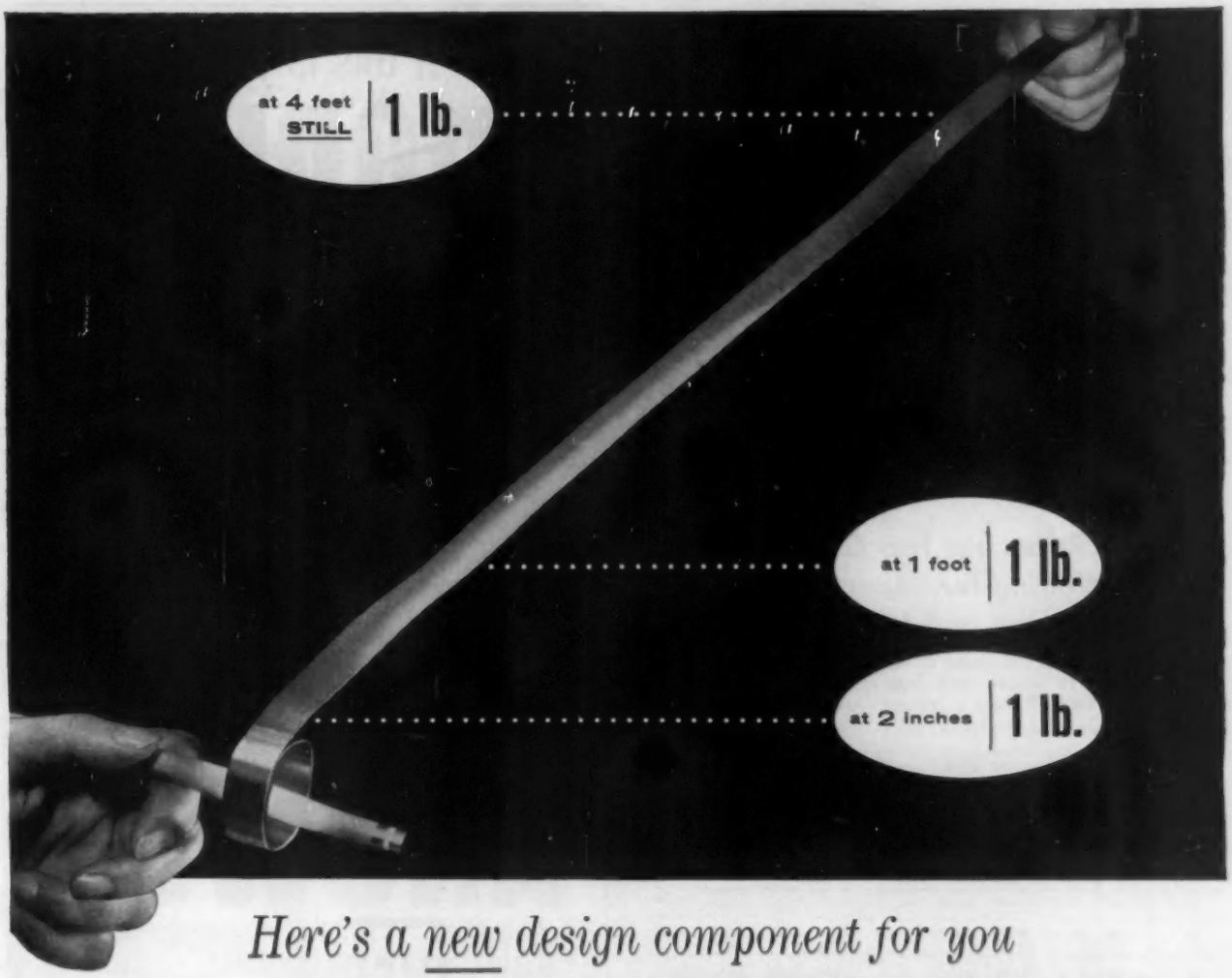
AN INSULATOR THAT PROVIDES A *GRIP!*



Made to customers specifications, this insulator has a sand lining fused to the inside to provide a strong, non-separating grip when it is cemented to a component part. The outside is finished in brown glaze.

Universal Porcelain Insulators are made to close dimensional tolerances, have uniform body density. They are high in physical and dielectric strength . . . withstand hot electrical arcing, thermal shock, vibration. They resist chemicals, moisture, fumes, heat and cold. And these characteristics remain unchanged during the life of the electrical unit in which they are used. Gain the advantage of Universal Porcelain on your next job! Our engineers are at your service.

THE UNIVERSAL CLAY PRODUCTS CO.
1545 EAST FIRST STREET U SANDUSKY, OHIO
TRADE MARK



Here's a new design component for you

THE FIRST CONSTANT FORCE SPRING!

Do *you*, too, want to simplify a product design problem—reduce weight, miniaturize, cut cost, *improve* the product, or even create a *new* product?

Can you use a *constant force spring* that's *not only a spring* but also a *motor*, a *counterbalance*, a *clamp*, *clip*, *slot closure*, and anything else *you* might make it?

The Hunter Neg'ator *constant force* spring upsets all previous spring principles. In addition to a zero gradient, negative or slightly positive gradients are also possible with the Neg'ator.

Hundreds of ingenious engineers have already used the Neg'ator spring to obtain—

- Tremendous extensions—over 30 times the original size—with no appreciable force build-up.
- Driving torques with longer duration and *no* heavy wind-up.
- Full force available from the very beginning of the stroke right up to the completion of the return stroke.
- The equivalent of a dead weight (in a range sufficient to counter-balance a mouse or a man) in one handful.
- Many other unusual characteristics.

Are *you* ready to learn more about this remarkable new spring element? We're ready to tell you. Just ask for our new bulletin, "The Hunter Neg'ator Spring". This bulletin describes the Neg'ator force characteristics, and its variety of forms and applications. Also included are many "thought provokers" for applying this promising new mechanical element.

THE HUNTER **neg'ator** constant force spring

HUNTER SPRING COMPANY

Lansdale (Phila.), Pennsylvania

SPRINGS • STAMPINGS • TEST APPARATUS

NOPAK Shelf-Stock Cylinders

CUT COSTS 3 ways

- **Low Prices but Top Quality**
- **No Waiting for "Specials"**
- **Less Design and Layout Expense**

Compare the prices and scope of NOPAK Shelf-Stock (1½ to 8" bore with 1 to 15" stroke) with competitive offerings and you'll specify these NOPAK Class 1 cylinders to cut costs.

LIST PRICES F. O. B. Milwaukee, Wisconsin — Subject to Revision

Cyl. Dia., Bore ↓	STOCK STROKE LENGTHS — All Double Acting								
	1"	2"	3"	4"	6"	8"	10"	12"	15"
1½"	24.16	25.72	26.08	26.44	27.16	27.88	28.60	29.32	30.40
2"	26.24	27.88	28.32	28.76	29.64	30.52	31.40	32.28	33.60
2½"	32.36	34.12	34.68	35.24	36.36	37.48	38.60	39.72	41.40
3"	35.04	37.28	37.92	38.56	39.84	41.12	42.40	43.68	45.60
4"	40.84	43.68	44.52	45.36	47.04	48.72	50.40	52.08	54.60
4½"	48.96	51.92	52.88	53.84	55.76	57.68	59.60	61.52	64.40
6"	66.60	70.80	72.20	73.60	76.40	79.20	82.00	84.80	89.00
8"	———	126.80	129.20	131.60	136.40	141.20	146.00	150.80	158.00

● Basic mountings "A" and "E" (see above) convertible to "B", "C", "D", or "F" (see below) by changing heads. Add 10% to above list prices (no extra charge for 8" bore.) ● Piston rods have B-1, NF male thread. ● Cushioning can be eliminated on either or both ends by removing spring and ball-check.

NOTE: Class 1 cylinders listed, for Air or Oil to 300 psi. Water use requires 1 week delivery for chrome plating of steel components.

NOPAK 4-Way Valves (¼ to 2" IPS) hand, foot, solenoid or pilot operated, to actuate all cylinders, also in Shelf-stock.

GALLAND-HENNING
NOPAK DIVISION
2762 SOUTH 31st STREET
MILWAUKEE 46, WIS.

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

NOPAK Shelf-Stock also maintained in other principal cities. Write for list.

A 8367-½V

---

if this is your

PROBLEM

If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, train employees, and perform any of the other communicative functions vital to your business . . .

this is your

ANSWER

The McGraw-Hill TECHNICAL WRITING SERVICE has a staff of more than 150 highly-trained writers, editors, and illustration specialists whose job it is to create technical and general literature for industry. We write, illustrate, design, and print Equipment Manuals, Product Bulletins, Handbooks, Company Histories, Annual Reports, and other specialized material. Save money and time. Let our staff be *your* staff for Technical and Business publications.

This service is available through ad agencies.

Write • Phone
TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.
LOngacre 4-3000

The J-M Friction Materials Specialist can help you find it

WHEN YOU'RE FACED with a problem calling for a friction material for use under extreme thermal conditions, ask the J-M specialist to help you. He can offer a wide choice of friction materials that have proved their ability to perform efficiently at operating temperatures up to 750° or more.

Available in low, medium and high friction coefficients, these linings and facings are specially engineered to withstand severe shock, maintain friction stability under critical temperatures, provide smooth action at a low rate of wear. If your requirements demand a friction material that must be custom-made for a special use . . . the Johns-Manville Research facilities are available to help develop that *just right* formulation.

Whatever your friction material problem, the J-M Friction Materials Specialist is at your service. Or, write for reference booklet FM-12A that contains a complete description of J-M Friction Materials and a handy selector chart. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville INDUSTRIAL FRICTION MATERIALS

SEARCHLIGHT SECTION

(Classified Advertising)

EMPLOYMENT: "OPPORTUNITIES" :EQUIPMENT
BUSINESS: :USED OR RESALE

EXPERIENCED DESIGNERS-LAYOUT MEN

TO WORK AT
GENERAL MOTORS
NEW TECHNICAL CENTER

For Experimental Automotive Work in Transmissions, Engines & Chassis.
The work of this group is carried on in one of the nations most modern and complete research and development centers; located in suburbs of Detroit, Michigan. Exceptional opportunity for men looking to the future. Positions are permanent due to long-range plans. Outstanding company benefits.

State Full Particulars; Age, Experience, Salary Expected Etc. Send Resume to:

PERSONNEL DEPT.
ENGINEERING STAFF
GENERAL MOTORS CORPORATION
G. M. Technical Center **Detroit 2, Mich.**

DESIGN ENGINEERS

A small, but expanding, manufacturer in New Castle, Indiana, in the building materials field, has excellent opportunities for two experienced graduate mechanical engineers in its Development and Engineering Departments. Work in these departments include new product design, primarily in light metal stampings and plastics, as well as fabricating machinery design, product improvement and cost reduction work. Salary—commensurate with experience and ability.

Please write

P-6275, Product Engineering
330 W. 42nd St., New York 36, N. Y.

PUMP DESIGNER

Desired by West Coast manufacturer. Experience in sand pump design desired, but not required. Please submit complete resume of experience with samples of work. All replies will be answered in strict confidence. Our employees know of this advertisement.

P-5519, Product Engineering
68 Post St., San Francisco 4, Calif.

DIRECTOR OF ENGINEERING

Salary Commensurate to Ability

Agricultural machinery and implements experience or somewhat allied. Company is solid - aggressive - further opportunity.

RAY EDWARDS AND ASSOCIATES
28 E. Jackson - Webster 9-2905 - Chgo., Ill.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)
LOS ANGELES: 1111 Wilshire Blvd. (17)

POSITIONS VACANT

Mechanical Sales Engineer—Qualified for bearing engineering and sales. Send brief history and salary desired. P-5498, Product Engineering.

Wanted: Expanding, progressive conveyor manufacturing company located in the East has need for an engineering executive to take over all phases of engineering and manufacturing. Mechanical engineering background, shop experience necessary. Preferably individual with conveyor experience but a good background in machine design would be satisfactory. Please submit complete resume including age, education, and experience. P-6072, Product Engineering.

ENGINEERING SALES ORGANIZATION

AVAILABLE

to cover Eastern Canada

Interested in controls suitable for machinery automation such as electric clutches, brakes, motor controls, etc. Highest technical references; full service facilities included. References and pertinent information exchanged.

RA-6134, Product Engineering
330 W. 42 St., New York 36, N. Y.

ATTENTION . . .

EMPLOYMENT ADVERTISERS

Effective with the July issue, a new section will start in Product Engineering. We will head this section: EMPLOYMENT OPPORTUNITIES. All Displayed Employment Opportunity advertising will be placed in this new section, with the exception of those advertisers who contract for run-of-book position. Advertising in the EMPLOYMENT OPPORTUNITIES section will be billed at the new rate of $19.85 which goes into effect with the July issue on all Displayed Employment advertising. Contract rates furnished on request. Ads are subject to Agency Commission.

REPRESENTATIVE

wanted for full line of
PLASTIC TOOLING RESINS

* * *

Experienced salesman, to cover Florida, Georgia, Alabama, Louisiana, Mississippi, Tennessee, North Carolina, South Carolina, West Virginia, Virginia. Should be familiar with tooling and metal forming methods. Engineering background helpful. Should be capable of assisting present customers and developing leads and inquiries turned over to him. Give complete details of education, experience, earnings, in letter to

The MARBLETTE Corporation
37-31 Thirtieth Street
Long Island City 1, N. Y.

PROFESSIONAL SERVICES

CONTROL DESIGN SERVICES

Automatic Machinery and Tool Design
Electro-Mechanical Systems Design

P. O. Box 8 Hillside Manor Br.
New Hyde Park, N. Y.

GEORGE H. KENDALL

Consulting Mechanical Engineers

Methods Studies: Process or Product
Redesign Existing Products for Greater Profit,
Trouble Shooting Production, Design, Cost Problems,
Specialist Automatic Machinery, Process, Controls,
New Developments, Patent Studies, Investigations,
New Products & Process Engineering Studies
P. O. Box 3 (*Est.* 1923) Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

WILLARD F. MASON

Consulting Electrical Engineer

Precision Electromechanical Designs
Specialist Slip Ring Assemblies—All Applications
Engineering Administration, Cost Systems
Product Development Programs
Manufacturing Facilities

189 Post Road, Darien, Conn. Oliver 5-9039

R. C. OSBORN and ASSOCIATES

Electro-Mechanical Engineering

- Automation
- Product Development
- Production Engineering

Box 251—Bloomington, Illinois

CONTRACT WORK

10 to 12 ft. lengths
ALL METALS
Also Screw Machine Products to Order
EASTERN
Machine Screw Corp.
12-32 Barclay St.
New Haven, Conn.
Makers of H & G Die Heads

Pacific Northwest manufacturer, financially and technically qualified now available for additional products to fabricate, assemble or completely manufacture.

Have full range of medium to heavy machine tools with large capacity, facilities for bench work, and a complete staff of mechanical and electrical engineers available. Write C-W-5835, Product Engineering, 68 Post St., San Francisco 4, Calif.

ENGINEERS • *Electronic* • *Electromechanical*
PHYSICISTS
SALES ENGINEERS

Burroughs
Research Center, Paoli, Pa.

Invites You

To Inspect Its Openings on Both Commercial & Sponsored Projects

Enjoy These Advantages!

In addition to paid vacations, liberal pension plans and numerous other valuable health and hospitalization benefits for you and your family, we provide cooperative educational aid at one of the many technical schools in the Philadelphia area for qualified applicants who find our center an ideal work-shop in which to secure the desired recognition in their chosen fields.

Your family, too, is important! And, here at Paoli, a delightful suburban community, thirty minutes from Philadelphia, you will find the cultural atmosphere as well as the educational facilities required for your children.

We will pay travel expenses for all applicants invited to visit our NEW Research Center to consider the application of their educational and/or work background to the many challenging problems we are engaged in for industry and the nation's welfare.

If you want the BEST for yourself and your family, consider NOW your qualifications for the openings listed on the right and —

Write **L. E. DICK**, *Personnel Manager*
BURROUGHS RESEARCH CENTER
Paoli, Pa.

Located on
PHILADELPHIA'S "MAIN LINE"

If you possess an educational and/or work background in Communications, Data Handling, Electronic, or Electro-Mechanical Business Machines...including such specifics as High Speed Mechanisms, Paper Handling Devices, Magnetic-Tape Transport Mechanisms, Magnetic-Drum or Tape Applications, Radar, Telemetering, Guided Missiles, Process Control Instrumentation, Digital and Analog Computers, Transistor and Magnetic Circuit Design and Analysis, Magnetic Amplifiers, Servo Mechanisms, and Electronic Packaging Design . . .

CONSIDER THESE OPENINGS AS

- **ELECTRICAL ENGINEERS; Junior & Senior**
- **MECHANICAL ENGINEERS; Junior & Senior**
- **LOGICAL DESIGNERS • PHYSICISTS**
- **PROJECT ENGINEERS**

- **SALES ENGINEERS** to sell E-101 electronic desk computers in all sections of the country. Sales & Technical experience in allied lines desirable.

RCA EXPANSION OPENS IMMEDIATE, ATTRACTIVE POSITIONS FOR

MACHINE DESIGN ENGINEERS

These are immediate opportunities for creative Mechanical and Electrical Design and Development of Automatic or Semi-Automatic Machines.

You should have a Bachelor or Advanced Degree in EE or ME, with at least 2 years' Machine Design experience.

You'll have your choice of work in Lancaster, Pa.—in beautiful Lancaster County about an hour's drive west of Philadelphia . . . or in **Harrison, N. J.**—just 18 minutes from downtown New York.

Among the many advantages which make RCA outstanding: Stimulating association with top engineers . . . exceptional laboratory facility . . . tuition financing for graduate study . . . company-paid insurance . . . a modern retirement program . . . relocation assistance . . . planned advancement programs to build your financial and professional future.

Thanks to big new Electron Tube expansion at RCA . . . these benefits, these opportunities are *yours* today. Start by sending resume of education, experience and location preferred to:

Mr. John R. Weid,
Employment Manager
Dept. A-5E, Radio Corporation of America
Camden 2, New Jersey

RCA ® **RADIO CORPORATION OF AMERICA**

ENGINEERS

DESIGNERS-DRAFTSMEN

Electronic *Mechanical*

What's *NEW* at Melpar

NEW **laboratories**

NEW **opportunities**

NEW **projects**

Melpar has just opened its new plant at Falls Church, Virginia, in a beautiful suburban location. We have also moved to larger quarters at Watertown, Mass., and opened a new research department at Cambridge, Mass.

Melpar's continued expansion offers new career opportunities for individual growth and recognition. Men of vision and imagination who plan for the future are quick to sense the potential with this growing, dynamic organization.

Continued leadership in electronic research and development is reflected in our current group of projects with long-range military and industrial application.

- Network Theory
- Systems Evaluation
- Automation
- Microwave Technique
- UHF, VHF OR SHF Receivers
- Analog Computers
- Digital Computers
- Magnetic Tape Handling Equipment
- Radar & Countermeasures
- Packaging Electronic Equipment
- Pulse Circuitry
- Microwave Filters
- Flight Simulators
- Servomechanisms
- Subminiaturization
- Electro-Mechanical Design
- Quality Control & Test Engineers

For personal interview send resume to
Technical Personnel Representative,

melpar, inc.
Subsidiary of Westinghouse Air Brake Co.
3000 Arlington Blvd., Dept. PE-17
Falls Church, Virginia
or 11 Galen St., Watertown, Mass.

MACHINE DESIGNERS

Expanding mechanical engineering research program has developed needs for designers with minimum of five years experience on large or small machines. Our present activities include applied research on internal combustion engines, scientific apparatus, special production machinery, and product design. These are career-type positions offering excellent promotional opportunities in a stable, progressive, independent research organization located in the midwest. Please address reply to

The Personnel Manager

BATTELLE MEMORIAL INSTITUTE

505 King Avenue Columbus 1, Ohio

MACHINE DESIGNER

for permanent and aggressive program

Must have at least 8 years experience and be able to design automatic machinery from specifications. Age 30-45. Long established communications equipment manufacturer. Plant located in community with fine schools, many cultural advantages, recreational facilities. Liberal bonus plan and other benefits.

Phone or write to Howard S. Gleason,
Manager Automation Research

Stromberg-Carlson Co.
ROCHESTER 3, N. Y.

Index of

PRODUCTS ADVERTISED

In This Issue

A

Accumulators 231

Actuators
Mechanical 278, 359

Adhesives 64

Air Motors (see Motors, Air)
Aluminum Alloys 2, 39, 114-115
303, 306, 325-326, 339, 391

Aluminum Coated Sheet and Strip
(see Steel, Coated)

Amplifiers 423

Assemblies
Hydraulic 313
Pneumatic 234-235, 313

Axles 394

B

Ball Joints 92, 312

Balls 404

Bars
Metal 10, 275, 355, 388B
Non-Metallic 285

Bearing Covers 392

Bearing Materials 103, 303

Bearings
Ball...15, 128, 221, 356 A & B, 373, 402
Needle 106
Oil-less.....71, 82, 103
Roller.....4th Cover
15, 51, 221, 223, 356 A & B
Self-Lubricating 288
Sleeve.....71, 82, 103, 275, 327, 388 B

Bellows 52-53, 298, 305, 405

Belts 14, 35-36-37, 60-61
320, 332, 345

Benders 271

Bi-Metal 366

Blowers 289, 322

Bolts 86-87, 229

Books 382

Boosters 231, 328

Brakes
Electric 16, 314
Pneumatic 225

Brass 2, 79, 107

Brazing
Alloys 244

Bronze 303

Brush Holders 276

Bushings 103, 263, 275, 288, 327

C

Cameras (see Photographic Equipment)

Cam Followers 209, 223

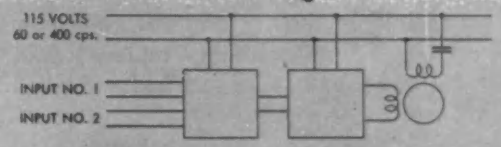
Continued on p. 424

NEW!

MINIATURE SERVO

Magnetic Amplifiers

Three New AC Servo Types Available..



STANDARDIZED SERVO SYSTEMS AND OTHER STANDARD TYPES FOR AUTOMATIC CONTROL —

In addition to new lines illustrated, many standard and higher power magnetic amplifiers are available for applications involving automatic control.

CUSTOM DESIGNS FOR SPECIAL REQUIREMENTS

— we design and engineer complete servo or automatic control systems

● **MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS**
Supply: 115 volt 400 cps.
Power output: 3.5, 6, 10, 18 watts
Sensitivity: 1 volt AC
Response Time: .03 sec.
Lowest Cost — Smallest Size
For further information request Form S493

● **MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER**
Supply: 115 volt 400 cps.
Power output: 5, 10, 15, 20 watts
Sensitivity: .1 volt AC
Response Time: .008 to .1 sec.
Highest performance — All magnetic
For further information request Form S496

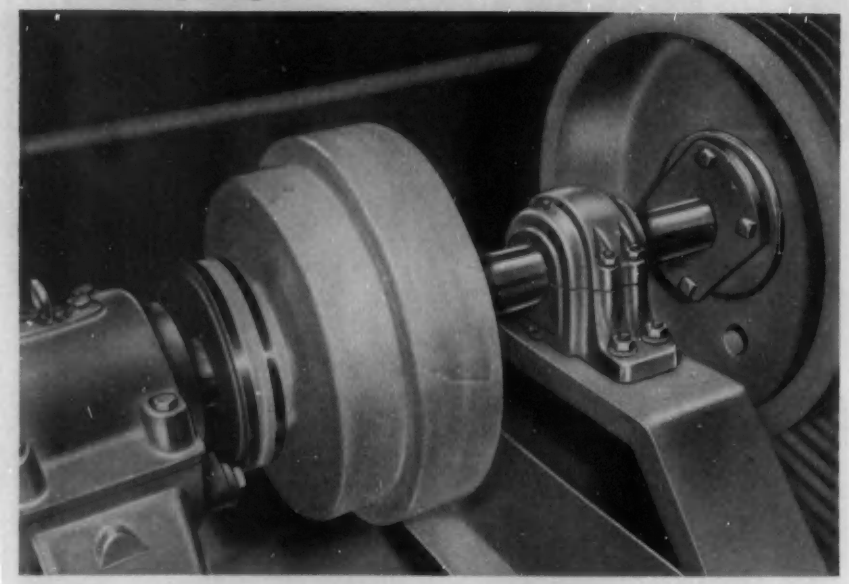
● **TRANSI-MAG*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER**
Supply: 115 volt 400 or 60 cps.
Power output: 2, 5, 10, 15, 20 watts
Sensitivity: .08 volt AC into 10,000 ohms
Response Time: .01 sec.
Fast response at high gain
For further information request Form S499 (400 cps.); Form S497 (60 cps.)

*TRADE NAME

AFFILIATE OF THE GENERAL CERAMICS CORPORATION

MAGNETIC AMPLIFIERS • INC
Telephone: CYpress 2-6610
632 TINTON AVE., NEW YORK 55, N. Y.

Here is one of the Stearns clutches installed at the Manitowoc Portland Cement Company. It transmits power from the motor to the preliminary grinding mill.



NO CLUTCH DOWN TIME

. . . even after 3 years of 24-hour-a-day service

Three years ago Manitowoc Portland Cement Company, Manitowoc, Wisconsin, installed Stearns magnetic clutches on two preliminary grinding mills used to crush stone to 20 mesh size. These clutches replaced heavy, outsized friction units which became misaligned and sometimes even twisted off and broke the drive shaft.

Not one cent of maintenance

The Stearns clutches are operating 24 hours a day and, according to James Dailey, superintendent and manager, they have not required a single adjustment or one cent of maintenance since installation. During this same period old clutches, still used on other grinding mills, broke down or required lining replacement . . . resulting in costly down time and loss of production.

Engage smoother, require less space

The Stearns clutches engage quickly, yet smoothly . . . require only ⅓ the space needed for the old clutches. They are controlled through convenient push buttons instead of hand levers.

Stearns magnetic clutches matched to your machine

Stearns offers clutches for equipment ranging from business machines to ball mills — and larger. Torque range from .1 lb ft to 30,000 lb ft. Available in a wide range of standard models or custom-built units to match your machine exactly. Get full details on the finest magnetic clutches available. Write today for bulletin 226-DJ.

1124

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 631 S. 28th St., Milwaukee 46, Wis.

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 423

Carbon 44-45
Carburetors 378
Casters 77
Castings 352, 382, 399
Castings, Precision Investment 238, 240, 384
Chains
- Bead 300
- Conveyor 383
- Roller 13, 74, 254, 370, 383
- Silent 13, 74

Chemical Treatments 8, 243, 280
Clips, Electrical 358
Closures 340
Clutches
- Electrical 408, 424
- Mechanical 54, 225, 262, 414, 431
- Pneumatic 225

Coatings 8, 62, 243, 280, 404
Coils 104-105, 400
Cold Headed Parts 229
Compressors 387
Computers 406
Connectors
- Hose 255, 313
- Tube 255, 313

Contacts & Contact Materials 104-105
Controllers 88-89, 358
Controls
- Electrical ..... 64 A & B, 88-89, 241, 292 A & B
- Electronic ..... 64 A & B, 257, 315, 416
- Hydraulic 112, 241, 308, 319
- Mechanical 384, 405
- Pneumatic 241, 308, 319

Copper & Copper Alloys 2
Cork Compositions 386
Counters 17
Couplings (see Connectors, Electrical)
Couplings
- Electrical 16
- Hose 255, 313
- Mechanical 262
- Tube 255, 313

Cylinders
- Hydraulic 231, 236-237, 249, 308, 319, 418, 436
- Pneumatic 231, 249, 308, 319, 341, 418, 436

D

Decalcomanias 348
Deep Drawing 40-41, 270
Die Castings 78, 245, 296, 370, 399

Index of

PRODUCTS ADVERTISED

In This Issue

Dies 294

Die Sets 274

Drafting
Machines .....96 A-B-C-D, 414
Supplies ....33, 96 A-B-C-D, 247, 414

Drives
Adjustable Speed.....26-27, 60-61, 259
Hydraulic 259
Variable Speed....16, 26-27, 60-61, 110

Dynamometers 16

E

Electrical & Electronic Components, Custom Made (see also Production Services).....397, 412, 423, 432

Electrochemical Finishes & Treatments 62

Enamel 62

Engineering Services (see also Production Services).....2, 32 40-41
368, 371, 386, 405, 428

Engines 227, 340, 405

Expanded Metals 293

Expansion Joints 405

Extrusions
Metallic 39, 306, 357 408
Non-Metallic 286, 302

F

Fabricated Plastics (See Plastics, Fabricated)

Fabricated Steel (see Plate Fabricated, Sheet Fabricated, Structural Forms & Shapes, see Weldments)

Fastening Methods.....69, 126, 362, 406

Fibre 403, 411

Fibre Glass 353

Filters
Air 234-235, 396
Hydraulic 396
Noise 38

Flexible Couplings.....74, 252, 262, 404

Flexible Shafts 400

Forgings 315, 339, 381, 396

Friction Materials.....36-37, 370, 419

Furniture, Engineering Dept..... 96
A-B-C-D, 287, 362

G

Gages, Pressure or Vacuum..... 256

Gaskets 36-37

Gear Motors (see also Motor Reducers)...3rd Cover, 26-27, 314, 343

Gears.....6, 11, 43, 68, 108-109, 122
211, 304, 371, 390, 425

Graphite 44-45

Continued on p. 426

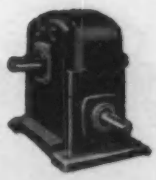
"Off the Shelf Service"

For Faster Deliveries — Greater Values . . . join the hundreds of nationally known firms whose engineers have proved the value of Ohio Stock Gears.

Ohio Gears are not limited to a few widely used types and diametrical pitches, but are designed to form a complete line of spur, bevel, helical, worm, and worm gears — to meet the widest variety of power transmission requirements.

You profit substantially when you standardize with Ohio Stock Gears . . . You avoid delays and costly down time.

Perhaps we could solve your power transmission problem as we have done in the past for so many industrial firms. Write us direct.



ESTABLISHED 1915

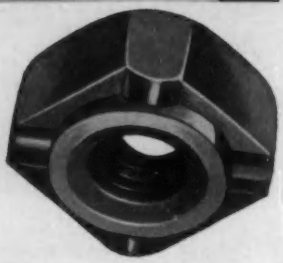
OHIO GEARS

The OHIO GEAR COMPANY • 1325 East 179th St. • Cleveland, Ohio

MIDLAND WELDING NUTS

...Make Tough Jobs Easy!

SAVE TIME!
SAVE TROUBLE!
SAVE MONEY!



If you've got a product involving metal fabricating, fastening or assembling, chances are you can use Midland Welding Nuts to big advantage.

They come in all sizes for every-sized job. Welded to the part or parts concerned, they don't have to be held while bolts are turned into them. Thus one man can often do the work of two.

And they're indispensable when it comes to those tucked away, hard-to-get-at places. Welded in advance to those inside spots where it is difficult—or *impossible*—for hands or tools to reach, Midland Welding Nuts hold fast while bolts are turned into them.

If you're a designer, you'll want to know about these time and labor-savers, too. Midland Welding Nuts will solve and simplify many of *your* problems, too.

Write or phone for complete information!

The MIDLAND STEEL PRODUCTS COMPANY

6660 Mt. Elliott Avenue • Detroit 11, Michigan

Export Department: 38 Pearl St., New York, N. Y.

Manufacturers of

Automobile and Truck Frames • Air and Vacuum Power Brakes
Air and Electro-Pneumatic Door Controls

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 425

H

Heating Units 120, 296, 378
Hermetic Seals 392
Hose & Tubing 36-37,.313

I

Instruments
Electrical 368, 433
Mechanical 368, 388
Insulation 266, 290, 411
Insulators 416

L

Lacquer 62
Lamps 63
Laminated Metals 31
Laminated Plastics (see Plastics, Laminated)
Latches 317
Liquid Level Controls..... 241
Lubricants 260
Lubricating Equipment..91, 234-235, 250

M

Magnesium Alloys.....80, 386, 408
Magnets 424
Manganese Alloys 303
Metal Forming 40-41
Moldings
Glass (see Glass Parts)
Plastics (see Plastic Parts)
Powdered Metal (see Powdered Metal Parts)
Rubber (see Rubber Parts)
Motor Reducers (see also Gear Motors) 108-109, 314, 343
Motor Starters 60-61
Motors, A-C
Fractional 18-19, 26-27, 28-29, 56-57, 60-61, 68, 100-101, 124 233, 239, 269, 273, 291, 297 331, 337, 343, 389
Integral.....18-19, 26-27, 28-29, 60-61 68, 93, 100-101, 239, 291, 314 331, 337, 388A, 389
Sub-Fractional 28-29, 56-57, 68 124, 233, 239, 289, 344
Motors, Air 284
Motors, D-C
Fractional...26-27, 28-29, 56-57, 60-61 68, 100-101, 124, 233, 239, 269 273, 291, 331, 343, 389
Integral.....26-27, 28-29, 60-61, 68 93, 100-101, 239, 291 314, 331, 388A, 389
Sub-Fractional.....28-29, 56-57, 68 124, 233, 239, 289
Motors, High Frequency Sub-Fractional 289
Motors, Hydraulic.....236-237, 281
Mountings 349

Index of

PRODUCTS ADVERTISED

In This Issue

•

N

Name Plates....348, 410
Nickel Alloys....98, 219
Nuts 34, 69, 76, 81, 95, 126 360, 370, 378, 416

O

Optical Parts 430
Overload Relays 104-105

P

Packings....36-37, 267, 375, 379 380, 427
Paper 285
Phospher Bronze 107
Pilot Lights 63, 257
Pins 362
Plastic Film 202
Plastic Parts 83, 258, 329, 415
Plastics ....32 A & B, 36-37, 58 85, 202, 204, 282, 286, 364-365
Plastics Fabricated....75, 363
Plastics Laminated 75, 202, 338 363, 403, 411
Plates 10
Porcelain 416
Powdered Metal Parts....4, 36-37, 82 265, 311
Power Packs
Hydraulic 319
Power Take-offs 414
Pressure Switches 257
Production Machines & Processes.. 376 413
Production Services (see also Engineering Services)....32, 40-41, 102, 335 354, 368, 371, 386, 405, 429
Pulleys 332
Pumps
Air 396
Liquid 55, 94, 112, 236-237,.281 328, 344, 361, 396, 406, 410, 434
Vacuum 395

R

Ratchets 390
Recorders 309
Regulators
Electric 358

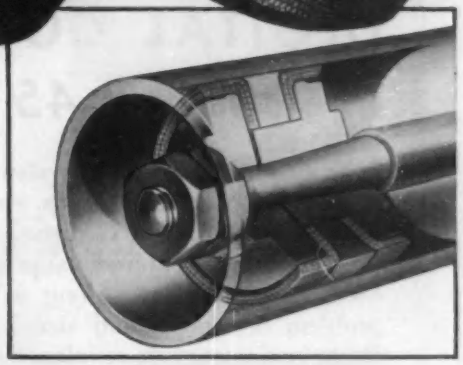
Continued on p. 428

PUMCUP ADVANTAGES

now yours for

• HYDRAULIC CONTROLS
• AIR CYLINDERS
• RECIPROCATING PUMPS

Two common Pumcup types: conventional and 45° bevel type . . available in a complete range of sizes and texture-engineered compositions.



Cutaway view of typical Pumcup installation resulting in prolonged high efficiency.

TAKE it from experienced users, Darcova Pumcups offer payoff advantages that can't be equalled! For example, they last many times as long as ordinary piston packing..and they *hold peak efficiency* from start to finish. Because of the resulting production and maintenance economies, plant after plant is standardizing on Pumcups.

Improved application of the cup principle does the trick. And Darcova Pumcups are *texture-engineered* in *a range of compositions* to meet most temperature-pressure-fluid conditions. And they are available in sizes and types exactly right for your particular equipment.

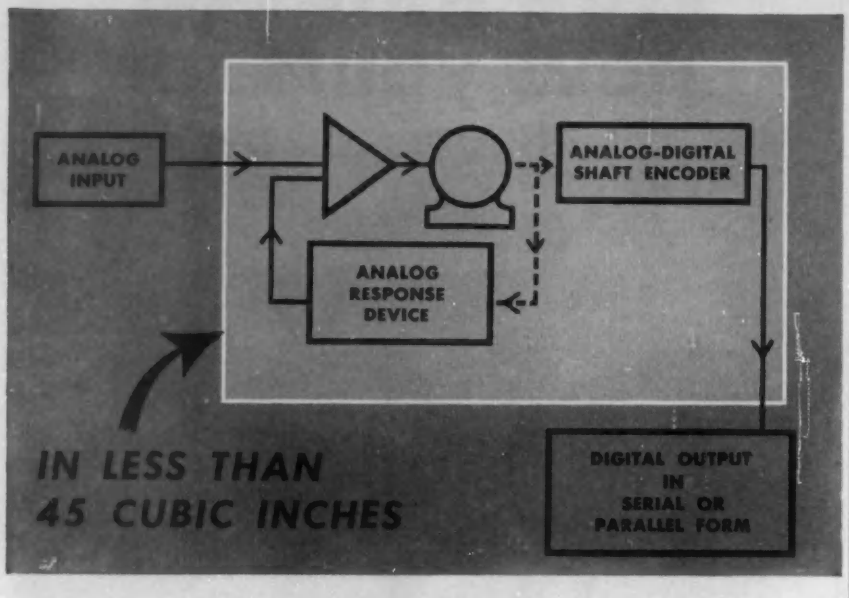
It will pay you to get *all* the facts. Just ask for Pumcup Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 25, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

TRADE MARK
PUMCUPS

SINCE 1915 LEADERS IN AUTOMATIC CONTROL


ANALOG INPUT
ANALOG-DIGITAL SHAFT ENCODER
ANALOG RESPONSE DEVICE
DIGITAL OUTPUT IN SERIAL OR PARALLEL FORM
IN LESS THAN 45 CUBIC INCHES

ANALOG TO DIGITAL CONVERSION in less than 45 cubic inches

In an aircraft navigational system, input information (such as compass headings, speeds, etc.) is received in analogs. The Ford Instrument Company engineers recently had a problem which required the presentation of this information in digital forms. Along with this was the physical problem of weight and size minimization. An Analog-Digital converter was developed which solved the problem. This unit occupied less than 45 cubic inches and required only line voltage with no special power supply.

This is typical of the way Ford Instrument engineers solve problems in the computing and control field. For forty years Ford has been pioneering techniques in servomechanisms; developing, designing and manufacturing systems and components to solve the complex problems of automatic control. Should you have a problem in control engineering it will pay you to talk to one of the Ford Instrument Company engineers.

56

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N.Y.

ENGINEERS
of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information.

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 427

Pneumatic 234-235
Relays 200, 295, 300, 393, 412
Reproduction Equipment....96 A-B-C-D 402, 409
Reproduction Supplies.....96 A-B-C-D 247, 330
Resins 47, 85, 116-117 316, 364-365
Retaining Rings 59, 410
Revolving Joints 312
Rivets 69, 95
Rod Ends 96
Rods
Metallic 303
Non-Metallic 258, 286
Rubber.....20-21, 49, 121, 282
Rubber-Bonded-to-Metal 263
Rubber Parts.....36-37, 248, 263, 302

S

Screw Fasteners 95
Screws 42, 48, 97, 99, 229 370, 388, 408, 414
Seals.....2nd Cover, 73, 253, 261 267, 321, 375, 380, 412
Servomechanism Components....324, 428
Shapes, Rolled Formed.....40-41, 367
Sheaves 332, 388
Sheets
Metal 10, 39
Plastic.....258, 286, 342
Silicones .....260 A & B, 266
Solenoids 323, 400
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.).. 34 65, 69, 76, 95, 126, 317, 360, 414
Speed Reducers.....43, 246, 307
Spinning 270
Splines 333
Springs.....22-23, 384, 417, 432
Sprockets.....13, 74, 254, 370, 390
Stampings.....40-41, 270, 377, 384, 400
Steel
Alloy.....86-87, 111, 213, 217
Carbon 113, 217
Coated 217
Stainless.....10, 113, 217, 347, 385
Strip, Metallic.....10, 217, 351
Structural Forms & Shapes....40-41, 72
Studs 229

Index of

PRODUCTS ADVERTISED

In This Issue

•

Subcontracting Services 270, 405
Switches.....24-25, 104-105, 200, 257
295, 310, 356, 393, 416
Swivel Joints 312

T

Tapes 286, 386
Tapes, Insulating (see Insulation)
Terminals & Terminal Boards..277, 392
Testing Machines & Equipment.... 264
Thermostats.....30, 50, 241, 348
Timers.....292, 300, 336, 398, 412
Timing Motors 350
Titanium.....86-87, 334
Tools 277, 358
Torque Converters 251
Transformers 400, 423
Transmission 26-27
Tubing
Plastic 258, 286, 395
Seamless 39, 65, 67, 215, 360
Welded 39, 84, 90, 242, 268

U

Universal Joints 272, 346

V

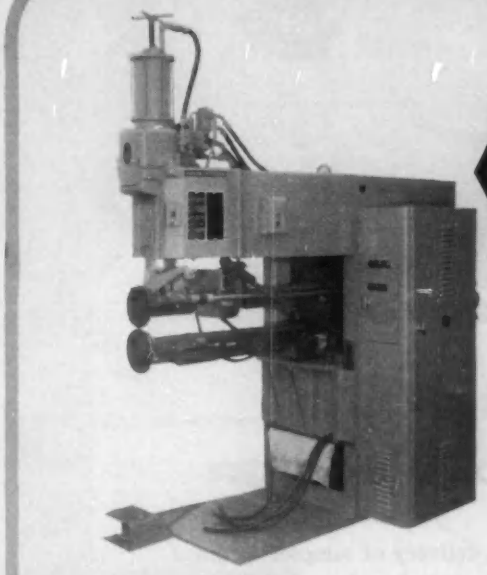
Valves
Air.....1, 234-235, 279, 308
319, 387, 418, 436
Hydraulic.....91, 236-237, 279, 308
319, 328, 332, 362, 418, 436
Vibration Mountings.....263, 301, 401
Vibratory Equipment 264

W

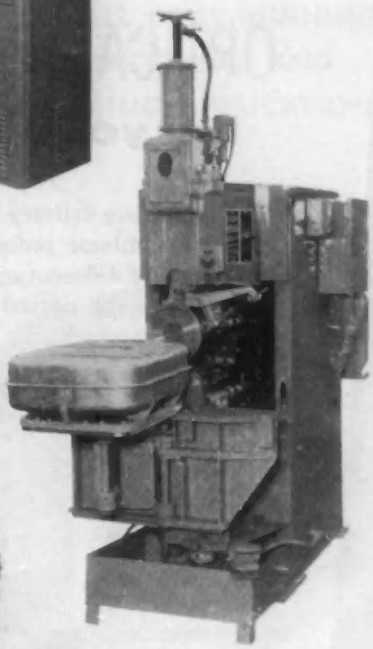
Washers (see Packings)
Welding
Equipment 413, 429
Nuts 426
Supplies 413
Weldments 40-41, 283
Wheels 372
Wire 46, 70, 102
Wire Cloth 320, 369, 374
Wire Forming 384

Z

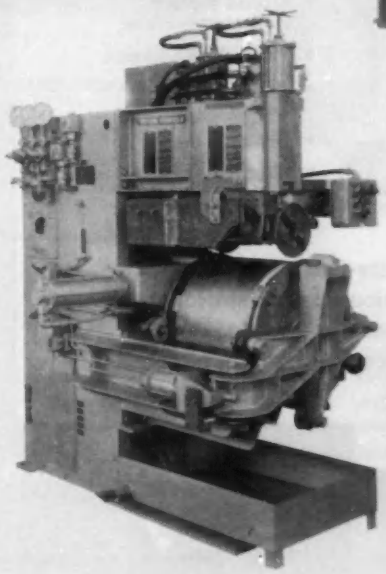
Zinc 12
Zinc Coated Strip..... 217



A STANDARD T-W RESISTANCE WELDER
Versatile uses; prompt delivery; lowest price.



OR A STANDARD WELDER MODIFIED
Special tooling; mechanized handling; increased production; low cost re-tooling.



OR A SPECIAL WELDER DESIGNED FOR YOUR WORK
Volume production at lowest unit cost.

Resistance Welders Since 1898

TAYLOR-WINFIELD
RESISTANCE WELDERS
SPOT • PROJECTION • SEAM • FLASH-BUTT

Sales and Service
CHARLOTTE • CHATTANOOGA
CHICAGO • CLEVELAND • DALLAS
DAYTON • DENVER • DETROIT
LOS ANGELES • PHILADELPHIA
PORTLAND, OREGON • SEATTLE
ST. LOUIS • STAMFORD • WASHINGTON
OAKVILLE AND WINDSOR, ONTARIO

THE TAYLOR-WINFIELD CORPORATION WARREN, OHIO

Rush Delivery!
OPTICAL PARTS
for your design
Get immediate delivery of samples; prompt action on volume orders for manufacture. Hundreds of different optical parts, production-run to the optical industry's highest precision standards.
• Plano-Convex Lenses
• Double-Convex Lenses
• Double-Concave Lenses
• Plano-Cylinder Lenses
• Positive Meniscus Lenses
• Negative Meniscus Lenses
• Projection Condensers
• Achromatic Lenses
• Right Angle Prisms
• Crown Glass Wedge-Type Prisms
• First Surface Reflectors —Plane
• Second Surface Reflectors—Plane
• Parabolic Reflectors
• Cylindrical Strip Lenses
• Ground Glasses
• Heat Absorbing Glass
• Retardation Plates
WRITE for Catalog L-117, and for information on special orders. Bausch & Lomb Optical Co., 66839 St. Paul Street, Rochester 2, N. Y.
BAUSCH & LOMB
SINCE 1853

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Acec Electric Corp. 291
Acme Chain Corp. 254
Acro Mfg. Co., Acro Switch Div. 356
Acushnet Process Co. 248
Aircraft-Marine Products, Inc. 277
Alemite 91
Alleheny Ludlum Steel Corp. 385
Allen-Bradley Co. ..... 64 A & B
Allen Mfg. Co. 99
Allied Research Products, Inc. 280
Allis-Chalmers Mfg. Co. 60-61
Allmetal Screw Products Co., Inc. 97
Aluminum Co. of America 360, 406
American Blower Corp. 259
American Brass Co. 79
American Chain & Cable Co., Inc. 256
American Chemical Paint Co. 243
American Hard Rubber Co. 282
American Screw Co. 97
American Steel & Wire Div., U. S. Steel Corp. 22-23, 46, 111, 113
Amplex Div., Chrysler Corp. 82
Arens Controls, Inc. 384
Armco Steel Corp. 10
Armstrong Cork Co. 386
Arwood Precision Casting Corp. 384
Atlantic Screw Works, Inc. 97
Austenal Laboratories, Inc. 240
Automatic Electric Sales Corp. 200
Automatic Switch Co. 279
Automotive Gear Works, Inc. 211
Avon Tube Div., Higbie Mfg. Co. 242

Bakelite Co., Union Carbide & Carbon Corp. 85, 364-365
Barber-Colman Co. 233
Barco Mfg. Co. 312
Barry Controls, Incorporated 301
Bausch and Lomb Optical Co. 430
Bead Chain Co. 300
Bearing Appliance Co. 392
Bethlehem Steel Co. 72
Bijur Lubricating Corp. 250
Blake & Johnson Co. 97
Bodine Electric Co. 124
Bond Co., Charles 404
Boston Gear Works 108-109
Boundbrook Oilless Bearing Co. 71
Bridgeport Brass Co. 107
Bristol Co., Socket Screw Div. 408
Brooks & Perkins, Inc. 386
Browning Mfg. Co. 388
Bruning Co., Inc., Charles ..... 96 A, B, C, D, 287, 409
Bunting Brass & Bronze Co. 275

Calidyne Co. 264
Cambridge Wire Cloth Co. 320
Carpenter Steel Co., Alloy Tube Div. 84
Carter's Ink Co. 33
Centralab Div., Globe-Union Inc. 397
Central Screw Co. 97
Century Electric Co. 100-101
Chace Co., W. M. 366
Chain Belt Co. 74
Chase Brass & Copper Co. 70
Chicago Molded Products Corp., Campco Div. 342
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Chicago Screw Co. 388
Chicago Thrift-Etching Corp. 410
Chrysler Corp., Industrial Engine Div. 227
Ciba Co., Inc., Plastics Div. 316
Clare Co., C. P. 295
Cleveland Cap Screw Co. 229
Cleveland Pneumatic Tool Co. 278
Cleveland Worm & Gear Co. 43

INDEX TO ADVERTISERS

Clifford Mfg. Co. 52-53
Cold Metal Products Co. 217
Columbia-Geneva Steel Div., U. S. Steel Corp. ..22-23, 46, 65, 111, 113
Consolidated Engineering Corp. 433
Continental Screw Co. 97
Coxhead Corp., Ralph C. 402
Cramer Co., Inc., R. W. 398
Crane Packing Co. 258
Crosby Co. 377
Crucible Steel Co. of America 347
Cullman Wheel Co. 370
Curtis Universal Joint Co., Inc. 272
Cutler-Hammer, Inc. 257, 416

Darling Valve & Mfg. Co. 427
Daystrom Instrument Div. of Daystrom, Inc. 368
Delco Products Div., General Motors Corp. 18-19
Denison Engineering Co. 112
Detroit Die Set Corp. 274
Detroit Sintered Metals Corp. 288
Dobeckmun Co. 354
Dormeyer Industries 400
Dow Chemical Co. 80
Dow Corning Corp. ..... 260 A & B
Driv-Lok Pin Co. 362
Drop Forging Association 381
Dudco Div. The New York Airbrake Co. 236
Dudek & Bock Spring Mfg. Co. 384
DuPont de Nemours & Co. Inc. E. I. Neoprene 49
DuPont de Nemours & Co. Inc. E. I. (Plastics) ..... 32 A & B
Durakool, Inc. 300
Dynamatic Div., Eaton Mfg. Co. 16

Eagle Lock Co. 97
Eagle Signal Corp. 292
Eastern Air Devices, Inc. 289
Eastman Kodak Co. Industrial Photographic Div. 247
Eastman Mfg. Co. 313
Eclipse Machine Div., Bendix Aviation Corp. 410
Elastic Stop Nut Corp. of America .. 81
Elco Tool & Screw Corp. 97
Electric Regulator Corp. 358
Electric Wheel Co. 372
Electro Dynamics Div. General Dynamics Corp. ..... 388 A
Emerson Electric Mfg. Co. 389
Enjay Co., Inc. 20-21

Fairchild Aircraft Div. Fairchild Engine & Airplane Corp. 435
Fairfield Mfg. Co. 304
Falk Corp. 307
Faultless Caster Corp. 77
Federal Die Casting Co. 296
Federal-Mogul Corp. 327
Federal Tool & Mfg. Co. 400
Fellows Gear Shaper Co. 376
Fenwal, Inc. 50
Firestone Plastics Co., Chemical Sales Div. Div. Firestone Tire & Rubber Co. 116-117
Flexonics Corp. 298
Flower Mfg. Co., D. B. 276
Ford Instrument Co. 428
Formsprag Co. 431
Frenchtown Porcelain Co. 404
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. 305
Fusite Corp. 392

Galland-Henning, Nopak Div. 418
Garlock Packing Co. 380
Gear Grinding Machine Co. 346
Gear Specialties, Inc. 11
General Electric Co., Apparatus Dept. 120
General Dynamics Corp., Electro Dynamics Div. 388-A

(Continued on Pg. 432)

How *Full Complement* Sprag type clutches give you better performance

GREATER TORQUE CAPACITY for size and weight.

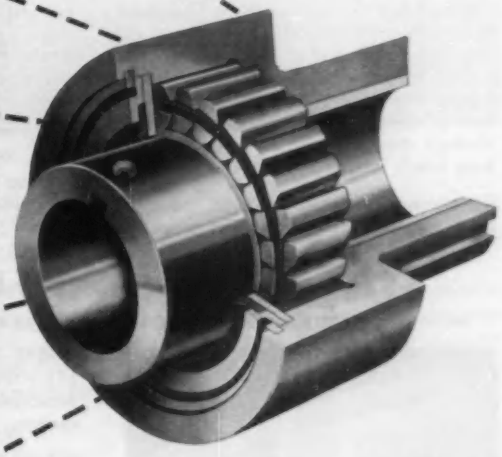
NO BACKLASH with full complement of sprags.

PRECISE, SILENT transmission of power.

LONG LIFE through low unit stress provided by infinite number of gripping positions.

INTERNAL SIMPLICITY —only 4 basic parts.

ON ALL OVER-RUNNING, BACKSTOPPING, AND INDEXING APPLICATIONS



These combined performance advantages are available to you only with a full complement sprag type clutch. And Formsprag manufactures the only full complement clutch on the market. It operates as simply as this:

The full complement of sprags inserted between outer housing and inner race are energized by springs.

Torque is delivered from one concentric member to the other through the sprags. Application of torque produces instantaneous engagement. Removal of torque causes immediate sprag release. Positive, precise engagement and disengagement can be made hundreds of times per minute with no backlash.

Put these construction and performance features to work for you in your next clutch application.

New catalog— send today.

FORMSPRAG *Company*

23607 Hoover Road
Van Dyke, Michigan

Distributors in Principal Cities.

How Beryllium Copper Springs keep foods fresher...longer

A BERYLLIUM COPPER SPRING is the "memory cell" of the defrosting mechanism of a leading household refrigerator. This small flat spring completely eliminates the necessity for remembering to defrost at the proper intervals. Thus, this beryllium copper spring functions in the defrosting timing cycle of the refrigerator — and through this increased efficiency, it helps keep foods fresher . . . longer.

The design engineers set rigid specifications for this defroster-actuating spring. They wanted, above all, maximum dependability and long life. The production department insisted on early and frequent deliveries after design details had been settled . . . and they wanted them in large quantities. And, naturally, the purchasing office demanded lower unit costs!

There's nothing too exceptional about these specifications. But there *is*, we believe, an unusual story in the manner in which they were exceeded—*on every count!*

I-S Micro-Processed Springs of Beryllium Copper

were chosen and are still being used for this installation because of their 4-way superiority:

You have the identical basic problems—time and unit costs, plus product performance. We feel that this particular spring application clearly demonstrates two important Instrument Specialty features: *(1) our ability to produce a better spring, faster and usually at lower cost to you. (2) the specialized ability of our engineers to cooperate with your designers in meeting practically any exceptional problem that involves spring-making.*

It cost you nothing to compare methods and costs.

(*1*) HIGHER DEGREE OF UNIFORMITY AND dependability than conventionally-made springs.

(*2*) I-S DESIGN ENGINEERS' SPECIALIZED experience in spring-making aided in redesigning for our exclusive "strip spring" technique which permits hardening in multiple fixtures to assure the uniform dimensional and elastic performance. This also resulted in substantial unit-cost reduction.

(*3*) THIS SAME I-S EXCLUSIVE STRIP DESIGN showed further savings in subsequent assembly-line operations—such as cleaning, inspection and attaching of the silver contacts and elimination of costly hand adjustments.

(*4*) ONLY I-S EXCLUSIVE TECHNIQUES, methods and patented equipment could have produced these far superior springs within the time limits set by the production department.

Instrument Specialties Co. Inc.

234-K BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY

Telephone Little Falls 4-0280

Our Catalog No. 9 is in Sweet's Product Design file —or write today for your own copy.

INDEX TO ADVERTISERS

(Continued from Pg. 431)

General Electric Co., Plastics Dept... 83
General Electric Co., Silicone Products Dept. 121
General Industries Co. 344
General Plate Div. Metals & Controls Corp. 31
General Tire & Rubber Co., Industrial Products Div. 263
Gerotor May Corp. 281
Gits Bros. Mfg. Co. 253
Gleason Works 6
Globe Industries, Inc. 408
Goodrich Co., B. F. (Rivnut)..... 69
Graton & Knight Co. 267
Great Lakes Screw Corp. 97
Great Lakes Steel Corp., Div. National Steel Corp. 213
Gries Reproducer Corp. 370
Grip Nut Co. 378

Handy & Harman 244
Hannifin Corp. 319
Hansen Mfg. Co., Inc. 350
Harper Co., H. M. 97
Hartford Steel Ball Co. 404
Hart Mfg. Co. 310
Harvey Aluminum Sales, Inc. 339
Haydon Co., A. W. 412
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 103
Heim Co. 96
Hellcoid Gage Div., American Chain & Cable Co., Inc. 257
High Duty Alloys, Ltd. 391
Hilliard Corp. 262
Hoke, Inc. 362
Hoover Co., Electric Motor Div. 297
Houghton & Co., E. F. 379
Howell Electric Motors Co. 337
Hughes Research & Development Laboratories 374
Hunter Spring Co. 417
Hyatt Bearings Div., General Motors Corp. 51
Hydreco Div., The New York Airbrake Co. 237

Instrument Specialties Co., Inc. 432
International Nickel Co., Inc. 98, 219
International Packings Corp. 267

Jahn Mfg. Co., B. 294
Jeffrey Mfg. Co. 383
Johns-Manville Corp. 261, 419
Johnson Bronze Co. 388B
Johnson Machine Co., Carlyle..... 54
Jones & Laughlin Steel Corp. 299

Kaiser Aluminum & Chemical Sales, Inc. 114-115, 325, 326
Kaydon Engineering Corp. 221
Kearfott Co., Inc. 324
Kellogg Co., M. W., Chemical Mfg. Div. 204
Kilian Mfg. Corp. 402
Koven & Bro., Inc., L. O. 335
Kraissl Co., Inc. 396

Lamb Electric Co. 343
Lamson & Sessions Co. 34, 97
LaSalle Steel Co. 355
Lehigh, Inc. 284
Leland Electric Co., Div. The American Machine & Foundry Co. 331
Librascope, Inc. 406
Lincoln Electric Co. 413
Linde Air Products Co., Div. of Union Carbide & Carbon Corp. 266
Linear, Inc. 375
Link-Belt Co. 13, 15
Logansport Machine Co., Inc. 436
Lord Mfg. Co. 349

INDEX TO ADVERTISERS

Lubriplate Div., Fiske Bros. Refining Co. 260

McGill Mfg. Co., Inc. 209, 223
McGraw-Hill Book Co., Inc. 382
M B Mfg. Co., Inc. 401
Madison-Kipp Corp. 245
Magnesium Co. of America 408
Magnetic Amplifiers, Inc. 423
Mahon Co., R. C. 283
Malleable Founders' Society 382
Mallory & Co., Inc. P. R. 4, 38
Manhattan Rubber Co. 35-36-37
Manheim Mfg. & Belting Co. 345
Marsh Instrument Co. 388
Master Electric Co. (Speedmaster) .....3rd Cover
Maurey Mfg. Corp. 332
Mayline Co. 362
Mead Specialties Co. 341
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Meyercord Co., Name Plate Div. 348
Micro Switch Div. Minneapolis-Honeywell Regulator Co. 24-25
Midland Steel Products Co. 426
Miehle-Dexter Supercharger Div. Dexter Folder Co. 322
Miller Fluid Power Co. 231
Minneapolis Honeywell Regulator Co., Industrial Div. 241
Minnesota Mining & Mfg. Co. 64
Moraine Products, Div., General Motors Corp. 311
Mosinee Paper Mills Co. 285
Mueller Brass Co. 303
Mullins Mfg. Corp. Koldflo Div. 257

National Acme Co. 323
National Lock Co. 97
National Machine Products Co. 360
National Motor Bearing Co. Inc. 73
National Pneumatic Co., Inc., Holtzer-Cabot Motor Div. 273
National Pneumatic Co., Inc., Industrial Actuators & Controls ... 308
National Screw & Mfg. Co. 97
National-Standard Co. 369
National Steel Corp. 213
National Tube Div., U. S. Steel Corp. 65, 111, 113
National Vulcanized Fibre Co. 411
Naugatuck Chemical Div. U. S. Rubber 47
Newark Wire Cloth Co. 374
New Departure Div., General Motors Corp. 128
New Jersey Zinc Co. 12
The New York Air Brake Co. 236-237
Norgren Co., C. A. 234, 235

Ohio Gear Co. 425
Ohio Seamless Tube Div. of Copperweld Steel Co. 215
Ohmite Mfg. Co. .....292 A & B
O'Neil-Irwin Mfg. Co. 271

Packard Electric Div. General Motors Corp. 269
Palnut Co. 416
Parker Appliance Co. 255
Parker-Kalon Div. General American Transportation Corp. 42, 97
Parker Rust Proof Co. 8
Peerless Photo Products Inc. 330
Penn Metal Co., Inc. 293
Perkins Machine & Gear Co. 390
Pesco Products Div. Borg-Warner Corp. 361
Pheoll Mfg. Co. 97
Philadelphia Gear Works, Inc. 122
Pittsburgh Plate Class Co., Fiber Glass Div. 353

(Continued on Pg. 434)

in a nutshell...

What surprises most engineers the first time they see one of CEC's 4-300 Pressure Pickups is its small size. But when they learn of the performance, surprise often turns to amazement. With the 4-300's, there's no compromise on either compactness or accuracy . . . you get *both* in a single unit, with ruggedness that provides laboratory accuracy under the most adverse conditions of use.

For your next pressure measurement job . . . where you need high accuracy, rapid response and minimum size . . . check these important features, common to all CEC 4-300 Pressure Pickups . . .

WIDE CHOICE OF RANGES . . . gage, absolute and differential units . . . full-scale ratings low as 1 psi, high as 5000 psi.

ACCURACY . . . 0.75% maximum linearity deviation...unusually low hysteresis, temperature effects, and acceleration response.

EXTREME MINIATURIZATION . . . bodies as small as ½" in diameter.

STANDARDIZATION . . . same basic sensing element in all models . . . uniform excitation voltage and output greatly simplify system design and operation.

COMPLETE CALIBRATION CERTIFICATE . . . *all* characteristics measured . . . signed certificate sent with each pickup.

ADAPTABILITY...several mounting methods offered . . . standard fittings supplied.

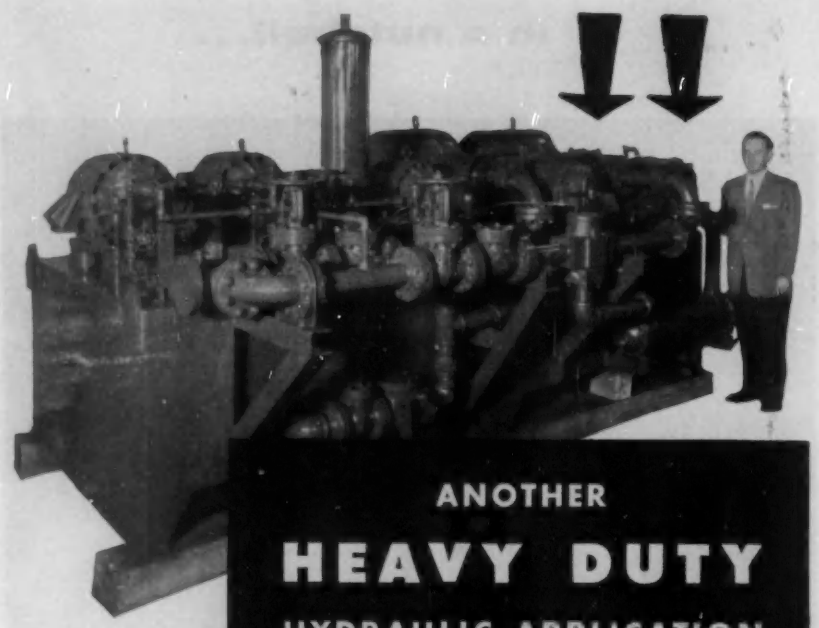
There's a CEC Pressure Pickup for almost every purpose. For complete information let us send you Bulletin CEC 1552-X18.

Consolidated Engineering
Corporation

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, Seattle, Washington, D. C.



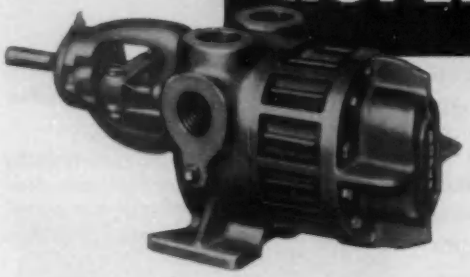
ANOTHER

HEAVY DUTY

HYDRAULIC APPLICATION

SOLVED WITH

ROPER PUMPS



Series F Pump . . . for pumping clean liquids of all kinds. Pressures to 300 P.S.I. — sizes 1-300 G.P.M.

SPECIAL HYDRAULIC APPLICATION USING STANDARD ROPER SERIES "F" PUMPS

THE PROBLEM: Develop a centralized hydraulic power unit to operate large elevators and hydraulic pushers through a continuous heat treating and annealing furnace in a steel mill.

THE ANSWER: The enormous hydraulic unit shown; as designed and built by Weinman Pump and Supply Co. of Pittsburgh.

This is but one of many special units developed by Weinman. And, here again, Roper Pumps were selected as integral parts of the complicated power system. Roper Series F Pumps are particularly adaptable to this and other applications because of their four-port design for ease of installation and their unusual *dependability* and *long life.*

You, too, can capitalize on improved performance records by including Ropers as original equipment. Our men in the field will be glad to give you all the assistance you need in the selection of the most suitable size pump for the job.

ROPER *Rotary Pumps*

SEND FOR CATALOG 955

Features the complete Roper line

GEO. D. ROPER CORPORATION

375 Blackhawk Park Ave., Rockford, Illinois

INDEX TO ADVERTISERS

(Continued from Pg. 433)

Polymer Corp. of Penna..... 395
Precision Castings Co., Inc..... 399
Precision Rubber Products Corp..... 321
Product Engineering 118-119
Progressive Mfg. Co..... 414
Protective Closures Co., Inc. CaPlugs Div. 340

Racine Hydraulics & Machinery Inc., 328
Ramsey Corp. 410
Raybestos-Manhattan, Inc. Manhattan Rubber Div..... 35
Raybestos-Manhattan, Inc. (Sales Div.) 36-37
Raybestos-Manhattan, Inc.....35, 36-37
Equip. Sales Div.
Manhattan Rubber Div.
Packing Div.
Reeves Pulley Co., Div. Reliance Electric & Engineering Co..... 27
Reliance Electric & Engineering Co. 26-27
Rem-Cru Titanium, Inc. 334
Republic Mfg. Co. 332
Republic Steel Corp. 86-87
Reuland Electric Co. 314
Revere Copper & Brass Inc.....2, 39
Reynolds Metals Co. 40-41
Reynolds Metals Co. Plastics Div.... 202
Rhode Island Tool Co..... 396
Richardson Co. 329
Robbins & Myers, Inc. 55-56-57
Robertshaw Thermostat Div., Robertshaw-Fulton Controls Co..... 348
Robotron Corp. 318
Rochester Products Div., General Motors Corp. 90
Rockford Clutch, Div. Borg-Warner Corp. 414
Rockford Screw Products Co..... 97
Rogers Corp. 75
Roll Formed Products Co..... 367
Roper Corp., Geo. D..... 434
Ross Operating Valve Co..... 1

SKF Industries, Inc.....356 A & B
Saginaw Steering Gear Div., General Motors Corp. 333
Sanborn Co. 309
Sandvik Steel, Inc. 351
Schundler & Co., Inc., F. E..... 290
Scovill Mfg. Co. 97, 317
Screw Research Association..... 97
Shakeproof Div., Illinois Tool Works. 97
Shenango Penn Mold Co..... 238
Simmons Fastener Corp..... 66
Smith Corp., A. O., Electric Motor Div. 93
Solar Aircraft Co..... 405
Soreng Products Corp. 336
South Chester Corp. Southco Div... 95
Southington Hardware Mfg. Co..... 97
Spaulding Fibre Co., Inc..... 363
Spencer Thermostat Div. Metals & Controls Corp. 30
Spincraft, Inc. 270
Square D Co. 104-105
Stalwart Rubber Co..... 302
Standard Pressed Steel Co.....48, 76
Standard Tube Co. 268
Stearns Magnetic, Inc. 424
Stephans-Adamson Mfg. Co. Sealmaster Bearings Div..... 373
Sterling Bolt Co. 97
Sterling Engineering Co., Inc., Div. American Machine Foundry Co. 393
Stewart Corp., F. W..... 400
Stewart-Warner Corp (Alemite)..... 91
Stewart Die Casting Div. Stewart Warner Corp..... 78
Stokes Machine Co., F. J..... 265
Sturtevant Co., P. A..... 358
Sylvania Electric Products, Inc. Parts Div 102, 415
Synthane Corp. 338

INDEX TO ADVERTISERS

Taylor Fibre Co. 403
Taylor-Winfield Corp. 429
Tennessee Coal & Iron Div.
U. S. Steel Corp. 22-23, 46, 111, 113
Thomas Flexible Coupling Co. 252
Timken Roller Bearing (Industrial) 4th Cover
Timken Roller Bearing Co.,
Steel & Tube Div. 67
Tinnerman Products, Inc. 126
Tomkins-Johnson Co. 249
Torrington Co. (Needle Bearing) 106
Torrington Co. Specialties Div. 32
Tourek Mfg. Co., J. J. 92
Twin Disc Clutch Co. 251

Union Carbide & Carbon Corp.
Bakelite Co. 85, 364-365
Haynes Stellite Co. 103
Linde Air Products Co. 266
United Aircraft Products, Inc. 412
United-Carr Fastener Corp.,
Ucinite Div. 63
United Chromium, Inc. 62
U. S. Axle Co., Inc. 394
U. S. Electrical Motors, Inc. ....324 A & B
U. S. Gasket Co. 286
U. S. Graphite Co. 44-45
U. S. Rubber Co. 14, 58
U. S. Rubber Co., Naugatuck
Chemical Div. 47
U. S. Steel Corp. 22-23, 46, 65, 111, 113
U. S. Steel Export Co. 22-23, 46, 65 111, 113
U. S. Steel Supply Div.
U. S. Steel Corp. 111, 113
Universal Clay Products Co. 416
Universal Drafting Machine Co. 414
Universal Screw Co. 97

Vard, Inc. 359
Veeder-Root, Inc. 17
Vickers, Inc., Div. of Sperry Corp. .. 94
Viking Pump Co. 406
Virginia Gear & Machine Corp. 122
Vulcan Electric Co. 378

Wagner Electric Corp. 239
Waldes-Kohinoor, Inc. 59
Wales-Beech Corp. 97
Warner Mfg. Corp. 306
Watlow Electric Mfg. Co. 296
Waukesha Foundry Co. Foundry Div. 352
Weckesser Co. 358
Weldon Tool Co. 344
Western Gear Works 371
Westinghouse Electric Corp. 28-29 68, 88-89
Wichita Falls Foundry & Machine Co. 225
Winsmith, Inc. 246
Wisconsin Motor Corp. 340
World Bestos Div.,
Firestone Tire & Rubber Co. 370
Worthington Corp. Multi-V Drive ... 110
Worthington Corp. 387
Wyman-Gordon Co. 315

Zenith Carburetor Div.
Bendix Aviation Corp. 378

■

PROFESSIONAL SERVICES 420

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.
EMPLOYMENT
Positions Vacant 420-422
Selling Opportunities Offered 420
Selling Opportunities Wanted 420
Employment Services 420

SPECIAL SERVICES
Contract Work 420

Index to Advertiser begins on P 430
Product Index begins on P 423

AN OLD PROVERB:

"He loses all . . .

who loses
the right moment"

This is a good time to consider whether or not the moment has come for you to make the change in your employment that can mean the beginning of a successful, productive and happy future.

Opportunities are outstanding right now at Fairchild Aircraft Division, for experienced aerodynamists and designers looking for interesting, provocative work in the forefront of aviation design, research and development.

Take stock of your present job. See whether you wouldn't rather have the kind of progressive, active and interesting job that Fairchild is offering to the right men.

Send your resume today to Walter Tydon, Chief Engineer.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

"where the future is measured in light-years"

Logan

Air-Draulic®

FEED CONTROLLED CYLINDERS

Combine The Fast-Acting, Economical Low-Pressure Operation Of ..... **AIR**

With The Smooth, Uniform Controlled Regulation Of ..... **OIL**

... for Pushing, Pulling, Pressing, Clamping, Holding, Lifting, and Other Power Movements In Any Direction

Air-Draulic Cylinder with Flange Mounting at Rod End

5 STANDARD MOUNTING TYPES

Standard bores from 3" to 8". Any stroke to 5'. For air pressure to 150 psi. Power movement in any direction. No power unit required. Feeds as low as 1.150 ipm; lower speeds special on request.

NO POWER UNIT REQUIRED

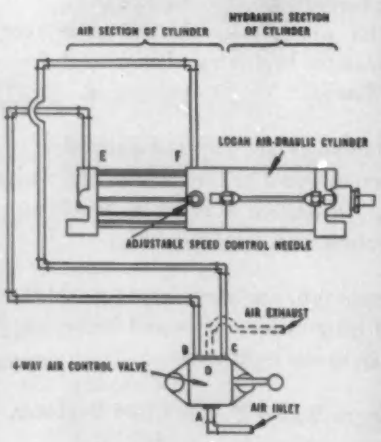
Basically, Logan AIR-DRAULIC® Cylinders are *air cylinders*, and may be used wherever compressed air is available. Yet they provide the smooth, uniform, controlled feed which is normally obtained only in *hydraulic cylinders*.

Reduced to its simplest terms, the Logan AIR-DRAULIC Cylinder is an integral unit consisting of an air piston and a hydraulic piston mounted on a single rod. The thrust or pull of the rod is obtained by means of the air cylinder, controlled by a valve or valves in the usual manner. The two chambers in the hydraulic cylinder are connected externally in a self-contained circuit; an adjustable speed control valve in this circuit regulates the flow of oil and hence the speed of the rod stroke.

Rapid return is made possible by a check valve in the hydraulic piston, permitting unobstructed oil flow on the return stroke. *Controlled feed in both directions* is also available by omitting the check valve. *Skip-feed* can be obtained through the use of cam valves applied externally in the hydraulic circuit.

The hydraulic circuit is self-contained, and no power unit is required. Logan AIR-DRAULIC Cylinders can be equipped with an automatic oil filler if desired.

Member—National Tool Builders Assn.
National Fluid Power Assn.



Basic AIR-DRAULIC Circuit with 4-Way Control Valve No Power Unit Required

HOW TO INSTALL AIR-DRAULIC CYLINDERS

The basic circuit for installation of Logan AIR-DRAULIC Cylinders is shown at the left. The air section of the cylinder is connected in the same manner as a standard double-acting air cylinder, a 4-way air control valve, piping and a connection to the main air line being required. A hand-operated air valve is illustrated, but foot-operated or other types of air valves may be used. The hydraulic section of the cylinder is a self-contained circuit and requires no additional equipment or connections.

Piping is arranged from ports B and C on the air valve to ports E and F, respectively, on the air section of the AIR-DRAULIC Cylinder. Port A is the air inlet port and port D the exhaust.

The desired piston speed is obtained by setting the adjustable needle on the hydraulic section of the cylinder. Controlled speed may be obtained on the out-stroke, the in-stroke, or both, through the internal arrangements of the hydraulic cylinder.

Let Logan engineers help you design your Air and Hydraulic Circuits. No obligation.

LOGAN MANUFACTURES 7,023 STANDARD CATALOGED ITEMS

FREE CATALOG ON REQUEST

AIR CONTROL VALVES, Cat. 100-4 • AIR CHUCKS, Cat. 70-1 • AIR CYLINDERS, Cat. 100-1 • AIR-DRAULIC CYLINDERS, Cat. 100-3 • AIR and HYDRAULIC PRESSES, Cat. 51 COLLET GRIP TUBE FITTINGS, Cat. 200-5 • HYDRAULIC CONTROL VALVES, Cat. 200-4 HYDRAULIC CYLINDERS, Cats. 200-2; 200-3 • HYDRAULIC POWER UNITS, Cat. 200-1 SURE-FLOW COOLANT PUMPS, Cat. 62.

Logan

LOGANSPORT MACHINE CO., INC.
812 CENTER AVE., LOGANSPORT, IND.

NEW 3-POINT EASY-TO-USE *READER SERVICE* TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalogs and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key number in the space indicated. Bulletins are described on pages 288-301.

To get more data about new Components, Materials and Parts fully described on pages 206-286, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T—Top; B—Bottom; R—Right; L—Left; TL—Top left; BL—Bottom left; TR—Top right; BR—Bottom right.

For specialized data . . . price, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space alloted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT No. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 5-55

NEW PRODUCTS... Description of these new engineering materials appear on pages 206 to 286. Circle key number for more data.

1—Pneumatic Amplifier and Motor
2—Separable Miniature Ball Bearings
3—Laminated Plastics
4—High-Speed Pressure Recorder
5—Two-Pressure Operating Valves
6—Powered Index Tables
7—Dished Plates Seal Ball Bearings
8—Insulated Metal Rivets
9—Hollow Lock Screws
10—Hollow Shaft Differential
11—Speed Reducers
12—Double-Enveloping Speed Reducer
13—Motorized Speed Reducers
14—Direct In-Line Drive
15—Instrument Spur Gears
16—Pressure-Lubricated Hinge
17—Multiple Torque Converter
18—Gusher Pump for Machine Tools
19—Vibration Damper
20—Pneumatic-Tired Casters
21—Shock-Resistant Relay ½ in.
22—Single-Pole, Double-Throw Relay
23—Rechargeable Battery 1⅛ In.
24—Frequency Sensitive Relays
25—Gasket-Mounted Pressure Switch
26—Hermetically Sealed Switch
27—Quiet Switches That Glow
28—Foot Switch 1⅛ x 1⅝ In.
29—Switches Rated at 10 Amp
30—Fhp Motor With Ribbed Base
31—Miniaturized Rotary Switch
32—Fhp Brake Motor
33—Reversible Electric Motor
34—Explosionproof Fhp Motor
35—A-c Motors Up to 30 Hp
36—Close-Coupled Pump Motor
37—Induction Motors ¼ to 1/100 Hp
38—Air-Cooled 3 Hp Gas Engine
39—Instantly Reversible Fhp Motors
40—Ice-Proof Switch
41—Dustproof Motor Arbor
42—Lightweight Miniature Connectors
43—Engine-Driven Electric Plants
44—Right-Angle Cartridge Unit
45—Molded Phenolic Jack Strips
46—Contact Terminals
47—Crimp Connector
48—Sealed Instrument Receptacle
49—Provides Firm Outlet Connection
50—Miniature Terminals and Contacts
51—Quick-Connect Plugs
52—Plastic Wiring Duct
53—Sheet Metal Enclosures
54—High Insertion Loss Filters
55—Line Filter For 115v, Ac
56—Striped Hook-Up Wire
57—Power Amplifier
58—Miniature Electronic Amplifier
59—Commutator and Impulse Generator
60—Clutch or Clutch Brake
61—Potentiometers for Industrial
62—Voltage Amplifier
63—Amplifier for 60 Cps Servo Motors
64—Counts Angular Change
65—Wire-Wound Resistor 7/16 x 3/16 In.
66—Flat Wire-Wound Resistors
67—High Speed Sampling Switch
68—Tantalum Capacitors
69—Rectilinear Motion Potentiometer
70—Pressure-Operated Potentiometer
71—Remote Operation of Valves
72—Absolute Pressure Control
73—Converts D-c Measurement
74—Smaller, Lighter Linear Actuator
75—Panel and Socket Thyratrons
76—Controls Pressures to 250 Psi
77—Electric Circuit Regulator
78—Data Transmission Terminal
79—Multiple Scale Meters

PRINT or TYPE your address on other side before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	22-3	26-5	26	27	28-9	30	31	32	33a-b	33	34	35
36-7	38	39	40-1	42	43	44-5	46	47	48	49	50	51	52-3
54	55	56-7	58	59	60-1	62	63	64	64a-b	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82
83	84	85	88-9	90	91	92	93	94	95	96	96a-d	97	98
99	100-1	102	103	104-5	106	107	108-9	110	111	112	113	114-5	116-7
	120	121	122	124	126	128	200	202	204	209	211	213	215
217	219	221	223	226	227	229	231	233	234	235	236	237	238
239	240	241	242	243	244	245	246	247	248	249	250	251	252
253	254	255	256	257	258	259	260	260a-b	261	262	263	264	265
266	267	268	269	270	271	272	273	274	275	276	277	278	279
280	281	283	285	284	285	286	287	288	289	290	291	292	292a-b
293	294	295	T296	B296	297	298	299	T300	B300	301	302	303	304
305	306	307	308	309	T310	B310	311	312	313	314	315	316	317
318	319	320	321	322	323	324	324a-b	325-6	327	328	329	330	331
L332	R332	333	334	335	336	337	338	339	L340	R340	341	342	343
L344	R344	345	346	347	L348	349	350	351	352	353	354	355	L356
356a-b	357	L358	TR358	BR358	359	L360	R360	361	L362	TR362	BR362	363	364-5
L366	367	368	369	L370	TR370	BR370	371	L372	373	L374	375	376	377
L378	TR378	BR378	379	L380	381	L382	R382	383	L384	TP384	BR384	385	L386
R386	387	L388	TR388	BR388	388a	388b	389	L390	391	L392	R392	393	L394
395	L396	R396	397	L398	399	L400	TR400	BR400	401	T402	BL402	403	L404
TR404	BR404	405	L406	TR406	BR406	L408	TR408	BR408	409	L410	TR410	BR410	411
TL412	BL412	413	L414	TR414	BR414	415	L416	TR416	BR416	417	T418	419	422
424	425	426	427	428	429	430	431	432	433	434	436	C3	C4

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154
155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182
183	184	185	186	187	188	189	190	191	192				

Card expires July 1

CIRCLE THESE KEY NUMBERS FOR FURTHER DATA ON.....

CIRCLE THESE KEY NUMBERS FOR INFORMATION ABOUT.....

CIRCLE THESE KEY NUMBERS FOR YOUR COPIES OF.....

USE THIS SPACE TO INDICATE REQUIRED.....

80—Panel Instrument Also Controls
81—Expanded Scale Voltmeters
82—Electric Heating Unit
83—Thirty Channel Recorder
84—Finned Electrical Heater
85—Ruggedized 2½ and 3½ In. Meters
86—Pressure Pilot
87—Miniature Axial Flow Blower
88—Germanium Power Rectifier
89—Miniature 1 In. Panel Meter
90—Porous Stainless Steel Snubbers
91—Speed Control of Cylinders
92—Hydraulic or Pneumatic Regulator
93—Adaptable Basic Valve Assembly
94—Air Valves With Locking Toggles
95—Check Valve for 0 to 10,000 Psi
96—Valve of 5 to 10 Gpm Capacity
97—Toggle Valve for 1000 Psi
98—Stainless Steel Solenoid Valves
99—Needle Valve Has One-Piece Body
100—Lubricated Plug Valve
101—Automatic Throttle Valve
102—Pump For Hydraulic Systems
103—Hydraulic Reservoirs
104—Union Bonnet, Rising Stem Valve
105—Variable Volume Vane Pump
106—Unwoven Fibers In Resin Binders
107—Coatings Based on Fluorocarbons
108—Vinyl Glass Sleeving
109—Rigid PVC Pipe
110—Vinyl Mastic Coating
111—Protective Insulation Coating
112—Fluxless Soldering Of Aluminum
113—Protective Paint
114—Measuring Magnifier
115—Drafting Template For Screws
116—Vacuum Tube Voltmeter
117—Time Interval Meter
118—Electronic Pressure Indicator
119—Remote Pressure Indicators
120—Measures Pressure, Temperature
121—Magnetic Voltage Regulators
122—Germanium D-c Power Supply
123—Parliamentary Rules
124—Calibrated Millivolt Supply
125—Transistor Oscillograph
126—Eight Channel Recorder

NEW BULLETINS . . . listed below are described on pages 783 to 301. Circle key number for your copy.

127—Electronic Timers
128—Relays
129—Cellulose Padding
130—Wire
131—General Purposes Rotary Pumps
132—Instruments and Controls
133—Industrial Slides
134—Color-Coded Terminals
135—Nylon Pressure Tubing
136—Roller Bearings
137—Gearmotors
138—Electric Motors
139—Polarized D-C Relays
140—O-Rings and Molded Parts
141—Blind Rivets
142—Single-Turn Potentiometer
143—Ductile Iron
144—High Alloy Castings
145—Nickel Copper Steels
146—Sheet Metal Cases and Covers
147—Vibration Specifications
148—Air Cylinders
149—Hydraulic Cylinders
150—Machinery Mounts
151—Miniature Capacitors
152—Synchronous Motors
153—Phosphor-Bronze Strip
154—Standards
155—Hydraulic Standards
156—Aluminum Extrusions
157—Vibration Mounts
158—Metal Hose
159—Screws, Nuts, Bolts, Pins
160—Brazing
161—Wrought Iron Pipe
162—Interval Timers

PRINT or TYPE your address on other side before mailing

... PRODUCTS ADVERTISED

... NEW PRODUCTS . . .

... NEW BULLETINS . . .

... SPECIFIC DATA . . .

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	22-3	24-5	26	27	28-9	30	31	32	32a-b	33	34	35
36-7	38	39	40-1	42	43	44-5	46	47	48	49	50	51	52-3
54	55	56-7	58	59	60-1	62	63	64	64a-b	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82
83	84	85	88-9	90	91	92	93	94	95	96	96a-d	97	98
99	100-1	102	103	104-5	106	107	108-9	110	111	112	113	114-5	116-7
	120	121	122	124	126	128	200	202	204	209	211	213	215
217	219	221	223	225	237	229	231	233	234	235	236	237	238
239	240	241	242	243	244	245	246	247	248	249	250	251	252
253	254	255	256	257	258	259	260	260a-b	261	262	263	264	265
266	267	268	269	270	271	272	273	274	275	276	277	278	279
280	281	282	283	284	285	286	287	288	289	290	291	292	292a-b
293	294	295	T296	B296	297	298	299	T300	B300	301	302	303	304
305	306	307	308	309	T310	B310	311	312	313	314	315	316	317
318	319	320	321	322	323	324	324a-b	325-6	327	328	329	330	331
L332	R332	333	334	335	336	337	338	339	L340	R340	241	342	343
L344	R344	345	346	347	L348	340	350	351	352	353	354	355	L356
356a-b	357	L358	TR358	BR358	359	L360	R360	361	L362	TR362	BR362	363	364-5
L366	367	368	369	L370	TR370	BR370	371	L372	373	L374	375	376	377
L378	TR378	BR378	379	L380	381	L382	BR82	383	L384	TR384	BR284	385	L386
R386	387	L388	TR388	BR388	388a	388b	389	L390	391	L392	R392	393	L394
395	L396	R396	397	L398	399	L400	TR400	BR400	401	T402	BL402	403	L404
TR404	BR404	405	L406	TR406	BR406	L408	TR408	BR408	409	L410	TR410	BR410	411
TL412	BL412	413	L414	TR414	BR414	415	L416	TR416	BR416	417	T418	419	423
424	425	426	427	428	429	430	431	432	433	434	436	C3	C4

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154
155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182
183	184	185	186	187	188	189	190	191	192				

Card expires July 1

163—Die Cast Fasteners
164—Remote Valve Control
165—Macro Camera
166—Photo Plastic Equipment
167—Cycling Timers
168—Gear Sets
169—Nitriding Processes
170—Tubing for Elevated Temperature
171—Shaped Wire
172—Ceramics
173—Laminated and Molded Plastics
174—Casters and Wheels
175—Porous Stainless Steel Filters
176—Gasoline Engines
177—Heavy Duty Pumps
178—Underwriter Pumps
179—Jacketed Pumps
180—Hydraulic Pumps
181—Special Applications Pumps
182—Pump Engineering Data
183—Stainless Tubing and Pipe
184—Solenoid-Operated Valves
185—Electric Motors
186—Hydraulic Constant Speed Drives
187—Expansion Valves
188—Nylon Powder
189—Ferrous Castings
190—Knobs and Handles
191—Ceilings
192—Ceramic Parts

USE THIS SERVICE

. . . to get your copies of new Catalogs and Bulletins

. . . for information on New Products listed in this issue

. . . for more information about products advertised in this issue

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT No. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

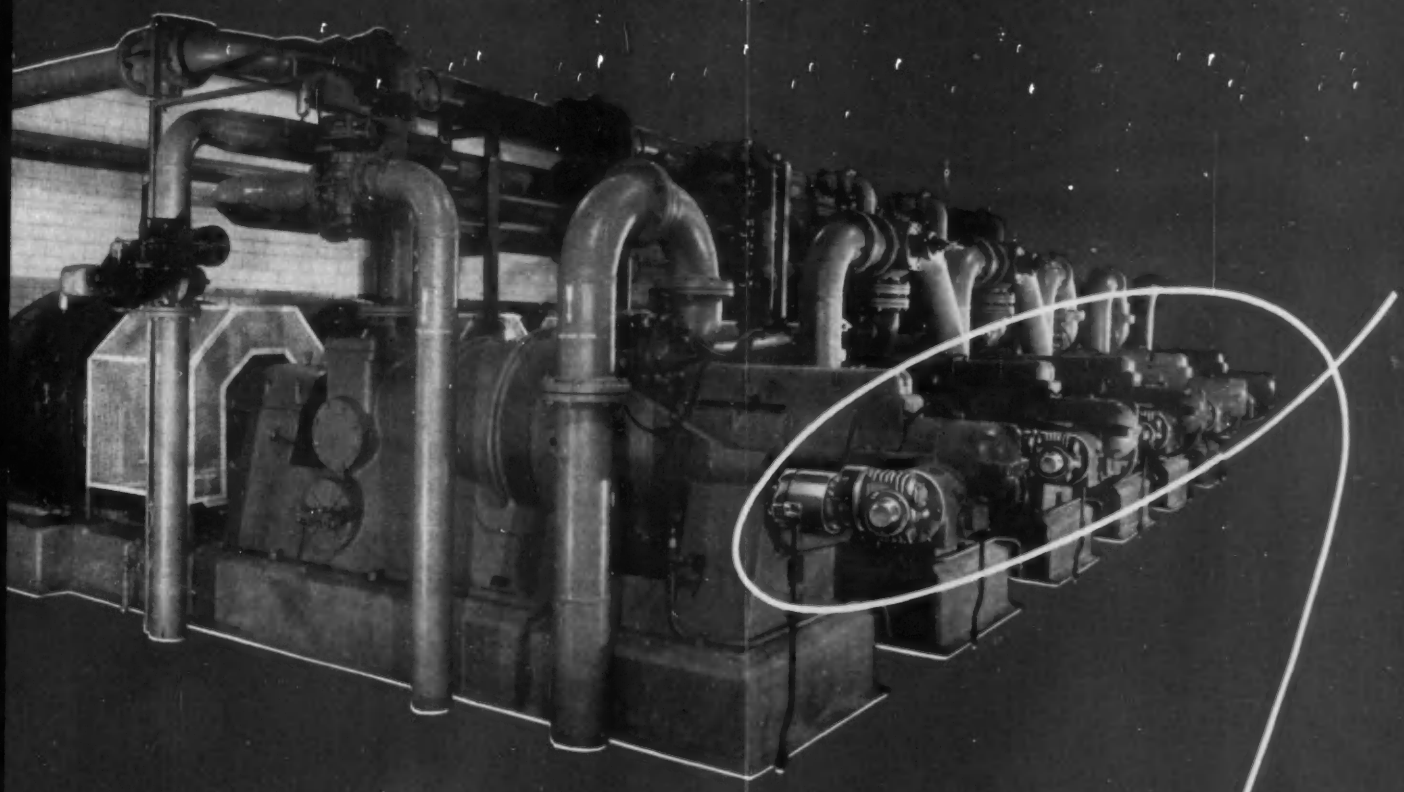
Position _____

Company _____

Address _____

City & State _____ 5-55

Requests for information made through *Product Engineering* Readers' Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.



When you must have slow speed power, always consider first MASTER Right Angle Shaft Gearmotors. They're very compact . . . low in cost . . . safe . . . and so easy to use.

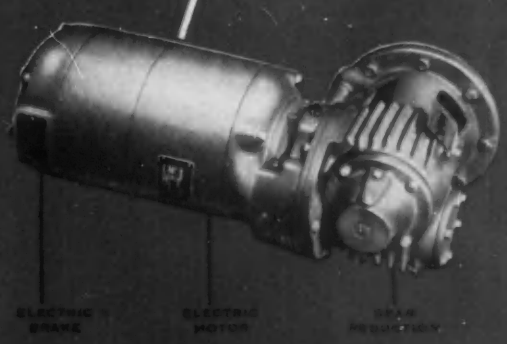
And nowhere else can you get anywhere near the wide range of selection that you have in MASTER Right Angle Gearmotors. They're available in sizes ⅛ to 25 Horsepower for all electrical specifications and in splash-proof, enclosed or explosion-proof construction. Gear reduction ranges up to 430 to 1 with the countershaft in either horizontal or vertical positions. In addition these gearmotors can be supplied with integrally built electric brakes . . . three types of variable speed units . . . and with fluid drive units for cushioned power.

Try them . . . you'll find they're the horsesense way to get slow-speed horsepower.

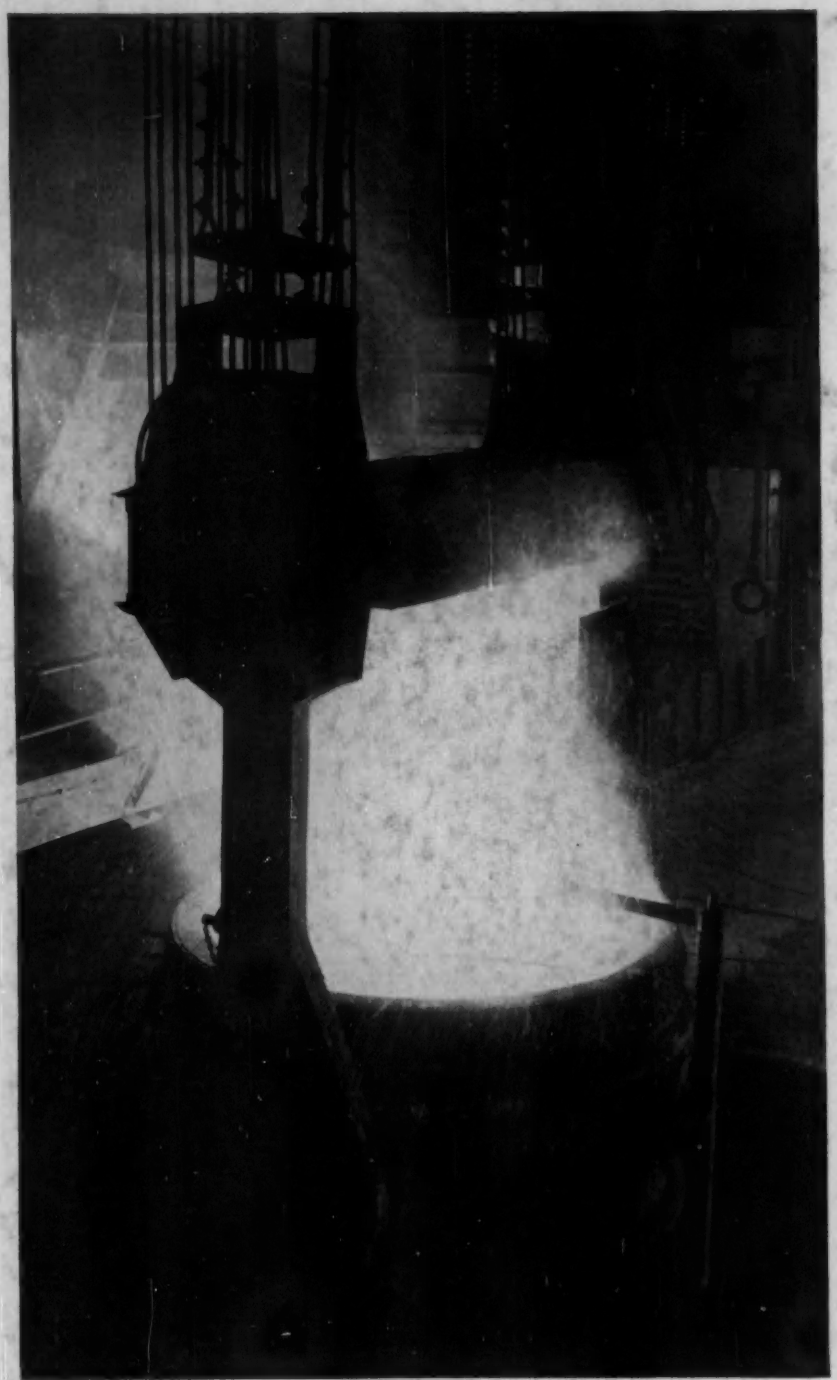
THE MASTER ELECTRIC COMPANY

DAYTON 1, OHIO

you can't beat them for compact slo-speed power



We make our own fine alloy steel—and make it nickel-rich—to make TIMKEN® bearings tougher

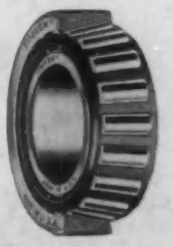


NICKEL makes steel tougher. So, our steel-making specialists don't skimp on nickel in the fine alloy steel we make for Timken® tapered roller bearings. They use exactly the right amount of nickel to give these bearings the toughness they need to withstand shock and last longer. Exacting quantities of chromium or molybdenum or both guarantee uniform hardness. By using the steel industry's first direct-reading spectrometer, we exercise hairline control of each element at the precise instant of tapping the furnace.

Rolling, annealing, and cooling are done with the same meticulous care. And every race and roller that goes into a Timken bearing is precision case-carburized to give it a hard, wear-resistant surface over a tough, shock-resistant core.

We've been specializing in the production of fine alloy steel for almost forty years. We're the only bearing manufacturer in the country that makes its own steel, because it's the only way we can make sure the quality of our bearing steel is just the way we want it. Steel is the heart of the bearing. That's why we insist on controlling bearing quality *every* step of the way—from melt shop to final bearing inspection. And that's why we don't skimp on the use of nickel.

To be absolutely sure of the highest performance standards in the equipment you build or buy, always specify Timken tapered roller bearings. They are made from seamless tubing or forgings by the most modern processes, under strict control. Only Timken bearings roll so true, have such quality thru-and-thru. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

Only **TIMKEN®** bearings roll so true, have such quality thru-and-thru